Hacettepe University Computer Science Department

BBM 233 – Logic Design Lab – Project 2

Report

Name Surname: Mert Çökelek

ID: 21727082

Email: b21727082@cs.hacettepe.edu.tr - 100mert101@gmail.com

Advisors: Cemil Zalluhoğlu, Selim Yılmaz, Selma Dilek

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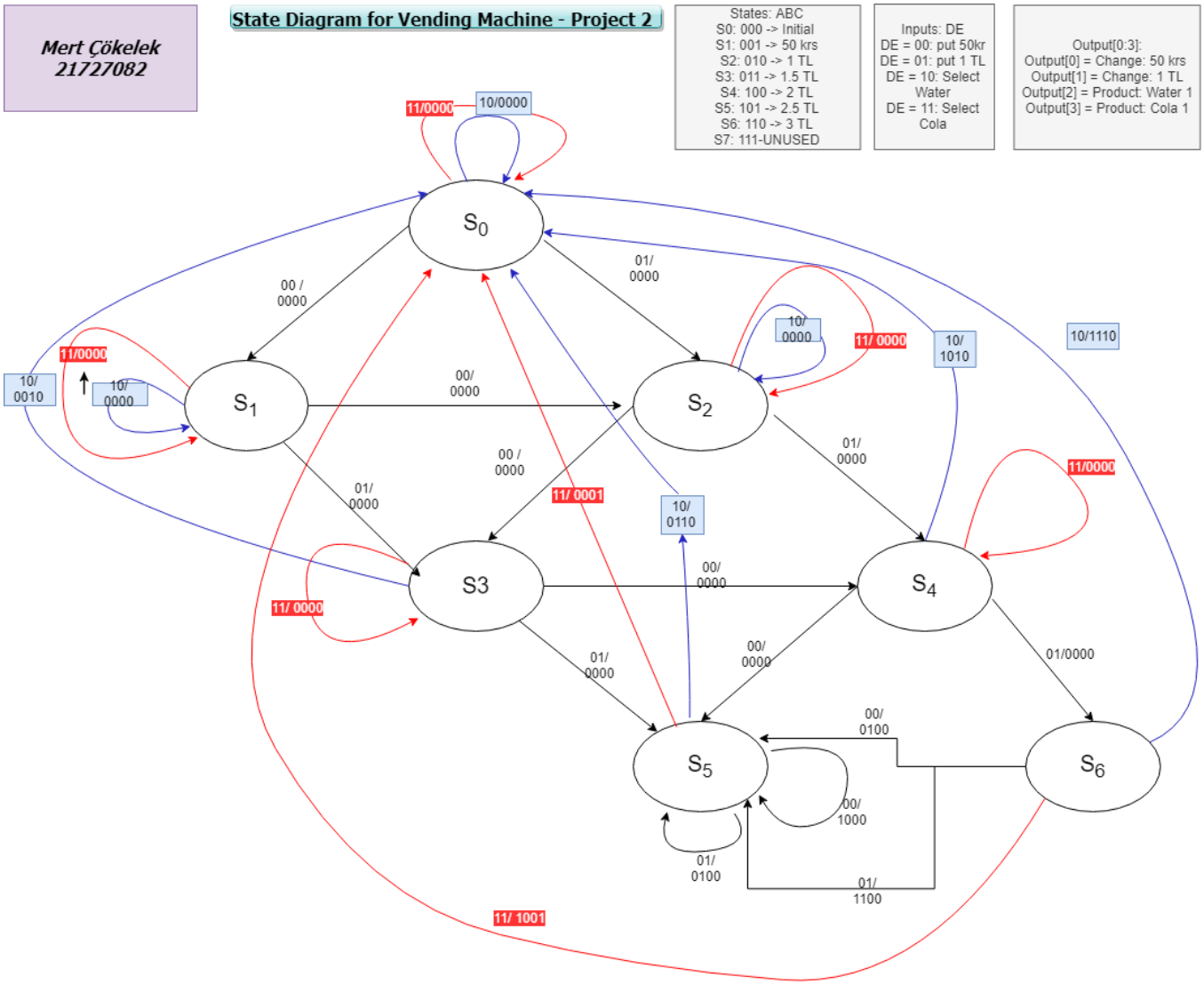
Subject: Implementing a simple vending machine which has inputs 50 krs and 1 ₺, Selections as Cola and water in Verilog HDL.

- **Here are my State Diagram, Verilog Codes and output as a waveform:**
- **1. State Diagram:**

Red lines: Cola selection

Blue lines: Water selection

Black lines: money insertion



- **2.a: vending_machine.v**

```
`timescale 1ns / 1ps


module vending_machine( state, nextState, Input, Clock, Reset, water_o, cola_o,
c50_o, c100_o);

    // "Input" corresponds to 4 different input combinations.

    // Input[1] = D, Input[0] = E;

    // DE = 00: insert 50 kr

    // DE = 01: insert 1 TL

    // DE = 10: select water
```

```
    // DE = 11: select cola


    input [1:0] Input;
    input Clock;
    input Reset;


    output reg water_o;        // Water product
    output reg cola_o;        // Cola product
    output reg c50_o;            // Change, 50 kurus
    output reg c100_o;        // Change, 1 TL
    output reg[2:0] nextState;
    output reg[2:0] state;



    // For readibility, naming the states.
    parameter [2:0] S0 = 3'b000;    // Initial State
    parameter [2:0] S1 = 3'b001;    // Total Coins: 0.5 TL
    parameter [2:0] S2 = 3'b010;    // Total Coins: 1 TL
    parameter [2:0] S3 = 3'b011;    // Total Coins: 1.5 TL
    parameter [2:0] S4 = 3'b100;    // Total Coins: 2 TL
    parameter [2:0] S5 = 3'b101;    // Total Coins: 2.5 TL
    parameter [2:0] S6 = 3'b110;    // Total Coins: 3 TL


    //------------------------------------------------------------
    initial begin
        water_o <= 0;        // Outputs (Products & Changes) are set to 0. Initial
state is assigned to 000 (No Coin Inserted).
        cola_o <= 0;
        c50_o <= 0;
        c100_o <= 0;
        nextState <= S0;
        state <= S0;
        end
    //------------------------------------------------------------
    always @(posedge Clock or posedge Reset)    // Any clock or reset pulses,
```

```
    begin
    if(Reset)        // If Reset is 1, Then set the Next State to 000.
        state <= S0;
    else
        state <= nextState;    // If Reset is 0, Then don't make any changes.
    end
    //----------------------------------------------------------
    always @(posedge Clock)        // Every Clock pulse, change the states
according to the inputs.
    begin


    case(state)
        S0:
            if(Input == 2'b00) // insert 50kurus
            begin
                nextState <= S1;    // Total: 50 krs, no product, no change
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 0;
            end
            //*****************************************
            else if(Input == 2'b01) // insert 1 TL
            begin
                nextState <= S2;    // Total: 1 TL, no output
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 0;
            end
             //*****************************************


            else if(Input == 2'b10) // Select Water
            begin
                nextState <= S0;        // Total: 0 TL, no output
```

```
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
        //*******************************************

        else if(Input == 2'b11) // Select Cola
        begin
            nextState <= S0;    // Total: 0 TL, no output
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
    //-----------------------------------------------------

      S1:
        if(Input == 2'b00) // insert 50kurus
        begin
            nextState <= S2;    // Total: 1 TL, no output
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
        //*******************************************

        else if(Input == 2'b01) // insert 1 TL
        begin
            nextState <= S3; // Total: 1.5 TL, no output
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
```

```
        c100_o <= 0;
    end
    //*****************************************
    else if(Input == 2'b10) // Select Water
    begin
        nextState <= S1;    // Total: 1 TL, no output
        water_o <= 0;
        cola_o <= 0;
        c50_o <= 0;
        c100_o <= 0;
    end
    //*****************************************
    else if(Input == 2'b11) // Select Cola
    begin
        nextState <= S1;
        water_o <= 0;
        cola_o <= 0;
        c50_o <= 0;
        c100_o <= 0;
    end
    //-----------------------------------------------
S2:
    if(Input == 2'b00) // insert 50kurus
    begin
        nextState <= S3;
        water_o <= 0;
        cola_o <= 0;
        c50_o <= 0;
        c100_o <= 0;
    end
    //*****************************************
    else if(Input == 2'b01) // insert 1 TL
    begin
        nextState <= S4;
```

```
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
   //*****************************************
        else if(Input == 2'b10) // Select Water
        begin
            nextState <= S2;
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
//*****************************************
        else if(Input == 2'b11) // Select Cola
        begin
            nextState <= S2;
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
  //---------------------------------------


     S3:
        if(Input == 2'b00) // insert 50kurus
        begin
            nextState <= S4;
            water_o <= 0;
            cola_o <= 0;
            c50_o <= 0;
            c100_o <= 0;
        end
```

```
 //*****************************************
           else if(Input == 2'b01) // insert 1 TL
           begin
               nextState <= S5;
               water_o <= 0;
               cola_o <= 0;
               c50_o <= 0;
               c100_o <= 0;
           end
//*************************************************
           else if(Input == 2'b10) // Select Water
           begin
               nextState <= S0;
               water_o <= 1;
               cola_o <= 0;
               c50_o <= 0;
               c100_o <= 0;
           end
//*************************************************
           else if(Input == 2'b11) // Select Cola
           begin
               nextState <= S3;
               water_o <= 0;
               cola_o <= 0;
               c50_o <= 0;
               c100_o <= 0;
           end
//-------------------------------------------------------
       S4:
           if(Input == 2'b00) // insert 50kurus
           begin
               nextState <= S5;
               water_o <= 0;
               cola_o <= 0;
```

```
                c50_o <= 0;
                c100_o <= 0;
            end
  //*****************************************************
            else if(Input == 2'b01) // insert 1 TL
            begin
                nextState <= S6;
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 0;
            end
//*****************************************************
            else if(Input == 2'b10) // Select Water
            begin
                nextState <= S0;
                water_o <= 1;
                cola_o <= 0;
                c50_o <= 1;
                c100_o <= 0;
            end
     //*****************************************************
            else if(Input == 2'b11) // Select Cola
            begin
                nextState <= S4;
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 0;
            end
    //-------------------------------------------------------
       S5:
            if(Input == 2'b00) // insert 50kurus
            begin
```

```
                nextState <= S5;
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 1;
                c100_o <= 0;
            end
 //*****************************************************
            else if(Input == 2'b01) // insert 1 TL
            begin
                nextState <= S5;
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 1;
            end
//*****************************************************
            else if(Input == 2'b10) // Select Water
            begin
                nextState <= S0;
                water_o <= 1;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 1;
            end
 //*****************************************************
            else if(Input == 2'b11) // Select Cola
            begin
                nextState <= S0;
                water_o <= 0;
                cola_o <= 1;
                c50_o <= 0;
                c100_o <= 0;
            end
  //-------------------------------------------------------
```

```
        S6:
            if(Input == 2'b00) // insert 50kurus
            begin
                nextState <= S5;
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 0;
                c100_o <= 1;
            end
 //*****************************************************
            else if(Input == 2'b01) // insert 1 TL
            begin
                nextState <= S5;
                water_o <= 0;
                cola_o <= 0;
                c50_o <= 1;
                c100_o <= 1;
            end
//*****************************************************
            else if(Input == 2'b10) // Select Water
            begin
                nextState <= S0;
                water_o <= 1;
                cola_o <= 0;
                c50_o <= 1;
                c100_o <= 1;
            end
  //*****************************************************
            else if(Input == 2'b11) // Select Cola
            begin
                nextState <= S0;
                water_o <= 0;
                cola_o <= 1;
                c50_o <= 1;
```

```
                c100_o <= 0;
            End

            default: nextState <= S0; // For the unused states, reset to Initial
State.
            endcase
            end
endmodule
```

2.b - Testbench.v

```
`timescale 1ns / 1ps

module vm_tb;

    // Inputs
    reg [1:0] Input;
    reg Clock;
    reg Reset;

    // Outputs
    wire Water;
    wire Cola;
    wire Change_50_kurus;
    wire Change_1_TL;
    wire [2:0] State;
    wire [2:0] NextState;

    // Instantiate the Unit Under Test (UUT)
    vending_machine uut (
        .Input(Input),
        .Clock(Clock),
        .Reset(Reset),
        .water_o(Water),
        .cola_o(Cola),
```

```
    .c50_o(Change_50_kurus),
    .nextState(NextState),
    .state(State),
    .c100_o(Change_1_TL)
);
initial Clock = 1;

always begin #10 Clock = ~Clock; end

initial begin

    // Initialize Inputs
    Input = 0;
    Reset = 1;

    #30;Reset = ~Reset;

    #30;    Input = 2'b00;
    #30;    Input = 2'b01;
    #30;    Input = 2'b01;
    #30;    Input = 2'b11;
    #30;    Input = 2'b00;
    #30;    Input = 2'b01;
    #30;    Input = 2'b01;
    #30;    Input = 2'b10;
    #30;    Input = 2'b10;
    #30;    Input = 2'b11;
    #30;    Input = 2'b00;
    #30;    Input = 2'b00;
    #30;    Input = 2'b00;
    #30;    Input = 2'b10;
    #30;    Input = 2'b00;
    #30;    Input = 2'b01;
    #30;    Input = 2'b01;
```

```
        #30;    Input = 2'b11;
        #30;    Input = 2'b00;
        #30;    Input = 2'b01;
        #30;    Input = 2'b01;
        #30;    Input = 2'b10;
        #30;    Input = 2'b10;
        #30;    Input = 2'b11;
        #30;    Input = 2'b00;
        #30;    Input = 2'b00;
        #30;    Input = 2'b00;
        #30;    Input = 2'b10;
        #1000;$stop;
        end

Endmodule
```

3. Waveform: