

UNIVERSITY OF CALIFORNIA, RIVERSIDE
Department of Computer Science and Engineering
Department of Electrical Engineering
CS/EE120B – Introduction to Embedded Systems
Final
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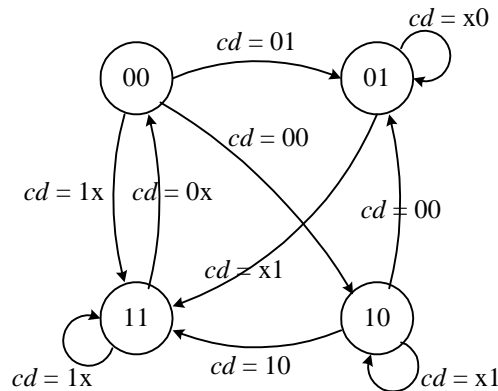
Name: Solution Key

Student ID#: _____

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(Numbers in parenthesis denote total possible points for question.)

1. Synthesize a FSM for the following state diagram using D flip-flops. Variables c and d are inputs. Leave all equations in canonical forms. You do not have to draw the circuit. (4)

**Answer**

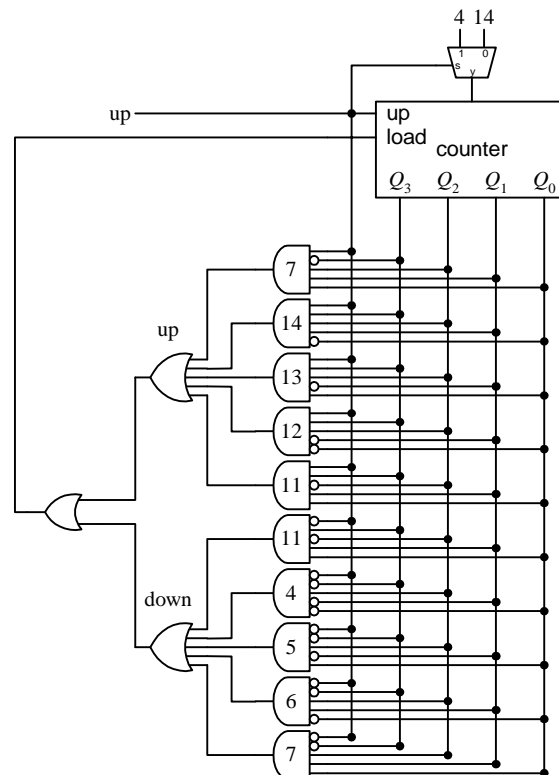
$$D_0 = CD' + Q_1'Q_0 + Q_1'D + Q_0C + Q_1Q_0'D'$$

$$D_1 = Q_1C + Q_1Q_0'D + Q_1'Q_0D + Q_1'Q_0'D'$$

2. Use a 4-bit up/down counter with parallel load to design a counter circuit that counts as follows.

When input up is asserted, the counter outputs the numbers 4, 5, 6, and 7 repeatedly in binary. When up is de-asserted, the counter outputs the numbers 14, 13, 12, and 11 repeatedly in binary. When the input up changes, the counter starts from the first number in the counting sequence, i.e. 4 in the up direction and 14 in the down direction. (4)

Answer



3. Determine the two addresses that will enable the input and output ports in the circuit in question 4. (4)

Answer

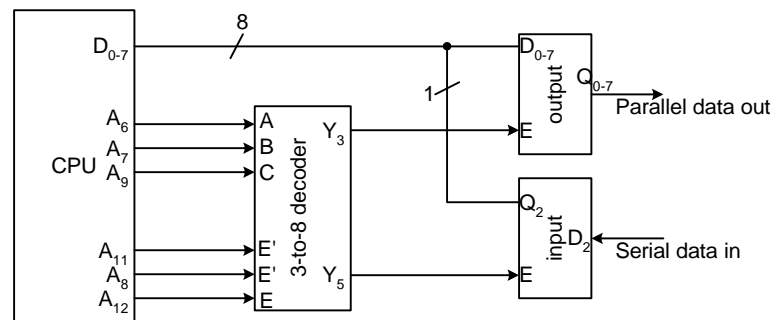
$$Y_3 = \$10\text{C0}$$

$$Y_5 = \$1240$$

4. Write a pseudo code program based on the following circuit so that the CPU will operate like the receiver part in an UART. In other words, the program will read from the serial data input and output the corresponding byte through the 8-bit output port. The program continuously performs this serial to parallel conversion as long as there is serial data input.

The format for the serial data is as follows: When the signal first drops to a 0, this is the beginning of the *start* bit. This is followed by eight data bits. After the last data bit, there is

one *stop* bit where the signal goes back to a 1. Assume that executing the function DELAY(20) with the time parameter 20 is equivalent to one bit period, and that all other instructions have a negligible delay. (4)



Answer

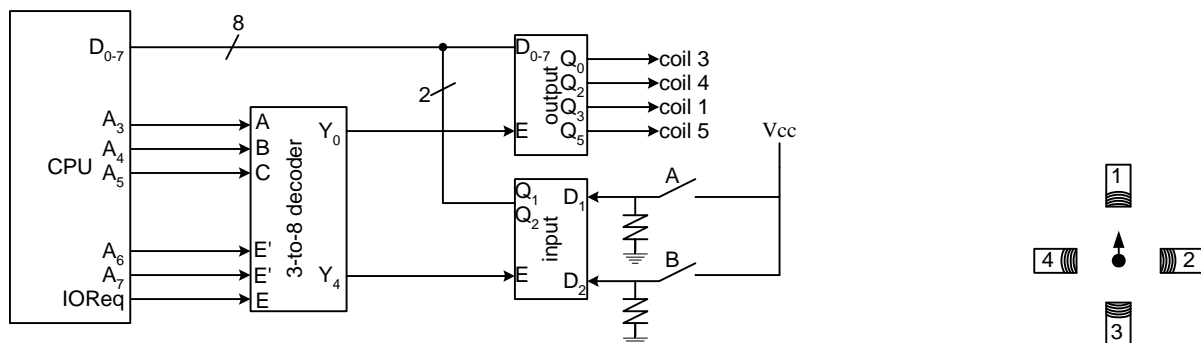
Again:

```
Repeat          // wait for serial line to go low
  In A, $1240
Until A(2) = 0
Delay(30)      // delay 1-1/2 bit period to middle of 1st data bit

For I = 0 to 7
  In A, $1240          // get data bit
  B(I) = A(2)          // mask bit 2 of A into B bit I
  Delay(20)            // delay until next data bit
End For

Out $10C0, B
Goto Again
```

5. Given the following stepper motor with four coils, and the circuit connecting two switches and the motor to the CPU as shown below, write a pseudo code to make the motor turn depending on the two switches. When switch A is pressed, the motor turns in the clockwise direction, and when switch B is pressed, the motor turns in the anti-clockwise direction. The motor stops when neither of the switches is pressed. The coils are turned on with a 1. (4)



Answer

```
//Input address Y4 = $20
//Output address Y0 = $00

Getkey:

In A,$20
If A = 2 Then
    // switch A is pressed
    goto clockwise
else if A = 4 then
    // switch B is pressed
    goto anti-clockwise
Goto Getkey

Clockwise:

Out $00,$08 // turn coil 1 on
Out $00,$20 // turn coil 2 on
Out $00,$01 // turn coil 3 on
Out $00,$04 // turn coil 4 on
Goto Getkey

Anti-Clockwise:

Out $00,$08 // turn coil 1 on
Out $00,$40 // turn coil 4 on
Out $00,$01 // turn coil 3 on
Out $00,$20 // turn coil 2 on
Goto Getkey
```