Instructions:

1. Please verify that your paper contains 8 pages including this cover.
2. Write down your Student-Id on the top of each page of this quiz.
3. This exam is closed book. No notes or other materials are permitted.
4. Total credits of this quiz are 45 points.
5. To receive credit you must show your work clearly.
6. No re-grades will be entertained if you use a pencil.
7. Calculators are NOT allowed.
Q1: [Controller Design]  [15 points]

Considering the FSM shown below:
X is the input to the FSM and Y is the output associated with each state.

![FSM Diagram]

a) Create the architecture for this FSM. [5 points]
b) Considering the state encoding shown below, draw the state table. [10 points]

A = 00, B = 01, C = 10, D = 11

NOTE: Just write the equation for the output Y.
Q2: [FSM Design] [10 points]

Design an FSM which detects strings of the form of 1(01)* on the stream of input X. On the detection of the string, an output Y should become 1.

1(01)* are a class of strings that start from 1, followed by any number of 01 (at least 0).

NOTE: 1, 101, 101…01, etc are some samples of a string of form 1(01)*.
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Q3: [Registers] [20 points]

Design inside the Black Box below to implement a 4-bit register with the functionality specified in the following table. $(A = a_3a_2a_1a_0$ is the output of the register.)
$B = b_3b_2b_1b_0$ is the input to the register.

NOTE: Specify the select lines of each multiplexer as well as the inputs. You can use the following components if needed.
- Adder
- Comparator
- Logic gates

<table>
<thead>
<tr>
<th>$S_1S_0$</th>
<th>Action</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Load</td>
<td>$b_3b_2b_1b_0$</td>
</tr>
<tr>
<td>01</td>
<td>Keep current value</td>
<td>$A$</td>
</tr>
<tr>
<td>10</td>
<td>If ($B&gt;A$) -&gt; Load B; else Keep current value</td>
<td>If ($B&gt;A$) -&gt; B; else A;</td>
</tr>
<tr>
<td>11</td>
<td>If ($B&gt;2^A$) -&gt; Load B/2; else Load A/2</td>
<td>If ($B&gt;2^A$) -&gt; B/2; else A/2;</td>
</tr>
</tbody>
</table>

![Black Box Diagram]