1. (5 points) How is -91 represented as an 8-bit 2s-complement binary integer?
ANS: 1010 0101

2. (10 points) What assembly language instruction corresponds to the hex value 0x018d4824? (Note: give the entire instruction, not just the op code!)
ANS: and $9,$12,$13

3. (6 points) Why was our 16-bit carry lookahead adder constructed from four 4-bit adders instead of 16 1-bit adders? Be specific.
ANS: When computing the carries for the high order bits, the equations are complex and prohibitively expensive. Adding the extra level of abstraction reduces the complexity of the circuits significantly at the expense of just two extra levels of gates.

4. (10 points) How is the number -93.1875 represented in the standard IEEE Single Precision Floating Point representation?
ANS: 1 10000101 01110100110000000000000

5. (15 points) For our single cycle design, fill in the following table for the or and lw instructions. Each element should contain 0, 1, or X (for "don’t care").
ANS:

<table>
<thead>
<tr>
<th></th>
<th>RegDst</th>
<th>ALUSrc</th>
<th>MemtoReg</th>
<th>RegWrite</th>
<th>MemRead</th>
<th>MemWrite</th>
<th>Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Or</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>lw</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

6. (10 points) In our single cycle design, suppose we replace the Sign Extension unit with a unit that just pads the 16 address bits from the instruction with 16 bits of leading 0’s. How would the branch instructions of our machine be affected? The jump instructions?
ANS: Only branches that jumped forward in the code would work. The jump instruction would not be affected since it doesn’t sign extend its address.

7. (10 points) Draw a finite state machine that says "yes" to all strings of 0 and 1’s that end in a 1 and contain the substring 00.
ANS:

[Finite State Machine Diagram]
8. (10 points) Give the NEXT-STATE and OUTPUT functions for the following FSM. Describe the set of strings that this machine says "yes" to.

![FSM Diagram]

ANS: This machine says yes to strings that have an even number of 1’s and end in a 0.

9. (12 points) Given multicycle design, fill in the values missing in the three empty ovals in the following figure.

ANS: See page 396 of your text.

10. (12 points) In the multicycle design, explain the use of the Memory Data Register. Why is it needed? When is it’s value used? By which instructions? On which cycles? Why is it necessary to also have an Instruction Register?

ANS: It is used to hold the value read from memory on the 4th cycle of a lw instruction so that it is available on the 5th cycle to be stored into the designated register from the register file. We must also have an Instruction Register because it needs to supply the write register on that same 5th cycle.