Question 1: (40 Marks)
a) Design an assembly language program that reads a list of 10 values stored at locations starting at $0020$, multiply this number by 2 and store the squares in a list starting at address $0040$. (15 Marks for the flowchart, 15 Marks for the source code)
b) Assuming the 10 successive memory locations contain the decimal numbers 0, 1, 2, … 9, show the status of the H, V, N, Z and C bits of the CCR after the execution of your program for the last two values in the list i.e. values 8 and 9. (10 Marks)

Question 2: (20 Marks)
Design a sequence detector to detect the sequence 110 and output a “1” whenever the sequence is completed including overlapping sequences.
Example: Input = 11000100111100111111000100111 ..
Output = 001000000100010000001000000 ..
Use JK Flip Flops. The truth table for the JK Flip Flop is shown in Table 1.

Table 1

<table>
<thead>
<tr>
<th>J</th>
<th>K</th>
<th>CLK</th>
<th>Q</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Q</td>
<td>No change</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Set</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>Reset</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Q*</td>
<td>Toggle</td>
</tr>
</tbody>
</table>

Question 3: (20 Marks)
1. Perform the following transformations (8 Marks)
   a) \((-18)_{10} = (?)_{2}\)
   b) \((-56)_{10} = (?)_{16}\)
   c) \((123)_{10} = (?)_{16}\)
   d) \((E5)_{16} = (?)_{10}\)

2. Perform the following hex additions: (4 Marks)
   a) \((5E)_{16} + (FA)_{16}\)
   b) \((F1)_{16} + (A032)_{16}\)

3. Perform the following hex subtractions (4 Marks)
   a) \((D0A)_{16} - (EE)_{16}\)
   b) \((5800C)_{16} - (135CF)_{16}\)

4. Perform the following division in Binary (4 Marks)
   a) \(11101110/101\)
Question 4: (20 Marks)
Describe a ADD ACCUMULATOR instruction cycle in the case of using indexed addressing mode. Assume that the operand is $FA, and the content of the index register is $0200.