Pregunta 1

	Assembler	Palabra de Control
		19-17 16-14 13-11 10 9-6 5 4 3 2 1 0
R1 ← ls R2	SHL 1, 2	001 000 010 0 1110 0 1 0000
R5 ← R1 + 6	ADI 5, 1, 6	101 001 110 1 0010 0 1 0000
M[R1] ← R3	ST 1, 3	000 001 011 0 0000 0 0 1 000
R4 ← M[R1]	LD 4, 1	100 001 000 0 0000 1 1 0 0 1 0
R6 ← R3	MOVA 6, 3	110 011 000 0 0000 0 1 0 0 0 0
if R4 = 0	BRZ 4, -7	111 000 001 1 0000 0 0 0 1 0 0
PC ← PC - 7		
else		
PC ← PC + 1		

7 = 000111

-7 = 111001

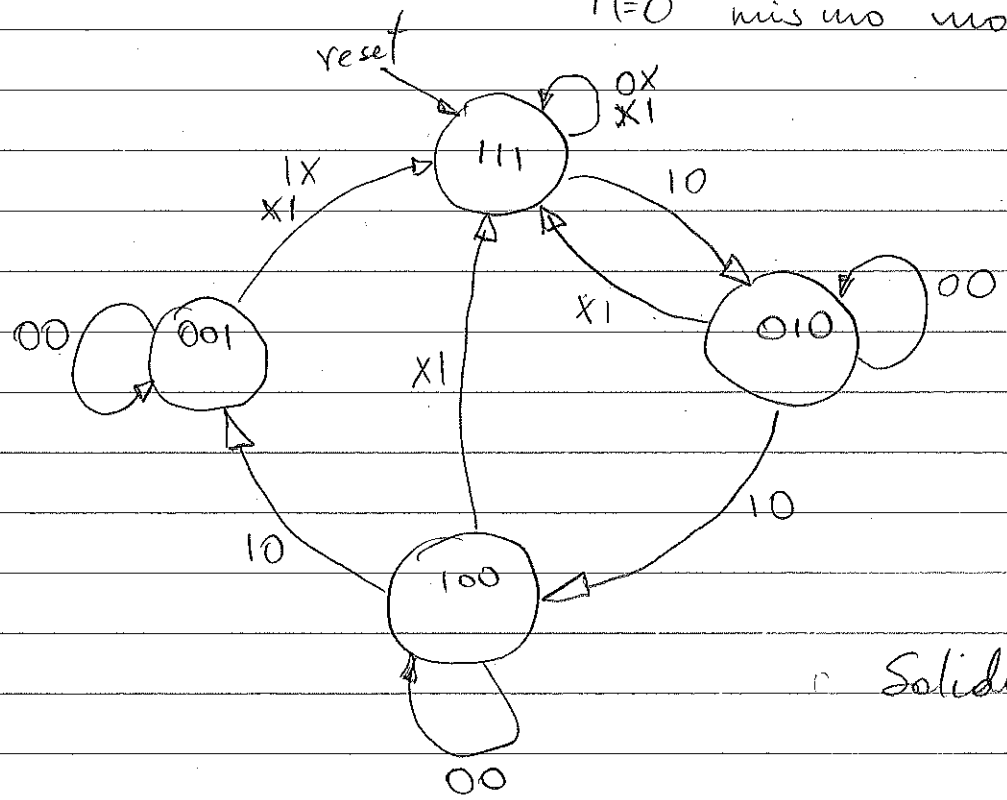
Pregunta 3

Máquina 1: contador 7, 2, 4, 1

entrada C C=0 → no cuenta
C=1 → cuenta

M M=1 cambio modo
M=0 mismo modo

} CM



Salidas: Leds
$L_2 L_1 L_0$

Q_2	Q_1	Q_0	C	M	Q_2^{t+1}	Q_1^{t+1}	Q_0^{t+1}
1	1	1	0	0	1	1	1
1	1	1	0	1	1	1	1
1	1	1	1	0	0	1	0
1	1	1	1	1	1	1	1
0	1	0	0	0	0	1	0
0	1	0	0	1	1	1	1
0	1	0	1	0	1	0	0
0	1	0	1	1	1	1	1
1	0	0	0	0	1	0	0
1	0	0	0	1	1	1	1
1	0	0	1	0	0	0	1
1	0	0	1	1	1	1	1
0	0	1	0	0	0	0	1
0	0	1	0	1	1	1	1
0	0	1	1	0	1	1	1
0	0	1	1	1	1	1	1

M=0

Q_2Q_1 \ Q_0C	00	01	11	10
00	X	X	1	0
01	0	1	X	X
11	X	X	0	1
10	1	0	X	X

M=1

Q_2Q_1 \ Q_0C	00	01	11	10
00	X	X	1	1
01	1	1	X	X
11	X	X	1	1
10	1	1	X	X

$$\boxed{Q_2^{t+1} = M + \overline{Q}_2 C + Q_2 \overline{C}}$$

M = 0

Q_2Q_1 \ Q_0C	00	01	11	10
00	x	x	1	0
01	1	0	x	x
11	x	x	1	1
10	0	0	x	x

M = 1

Q_2Q_1 \ Q_0C	00	01	11	10
00	x	x	1	1
01	1	1	x	x
11	x	x	1	1
10	1	1	x	x

$$Q_1^{t+1} = M + Q_1\bar{C} + Q_0C$$

M = 0

Q_2Q_1 \ Q_0C	00	01	11	10
00	x	x	1	1
01	0	0	x	x
11	x	x	0	1
10	0	1	x	x

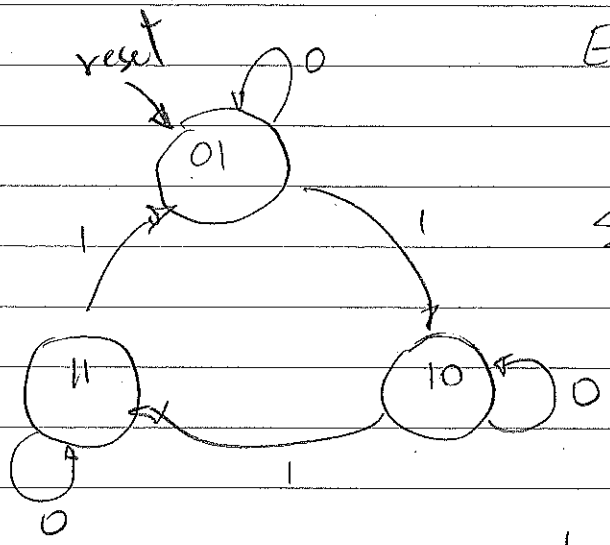
M = 1

Q_2Q_1 \ Q_0C	00	01	11	10
00	x	x	1	1
01	1	1	x	x
11	x	x	1	1
10	1	1	x	x

$$Q_2^{t+1} = M + \bar{Q}_1 + Q_0\bar{C}$$

$$L_2 = Q_2$$
$$L_1 = Q_1$$
$$L_0 = Q_0$$

Máquina 2: Máquina de modos



Entradas: M

M = 1 cambio modo

M = 0 mismo modo

Salidas: Estados de la máquina $E_1 E_0$

E_1	E_0	M	E_1^{t+1}	E_0^{t+1}
0	1	0	0	1
0	1	1	1	0
1	0	0	1	0
1	0	1	1	1
1	1	0	1	1
1	1	1	0	1

$E_1 E_0$ \ M	0	1
00	x	x
01	0	1
11	1	0
10	1	1

$$E_1^{t+1} = \overline{E_0} + E_1 \overline{M} + \overline{E_1} M$$

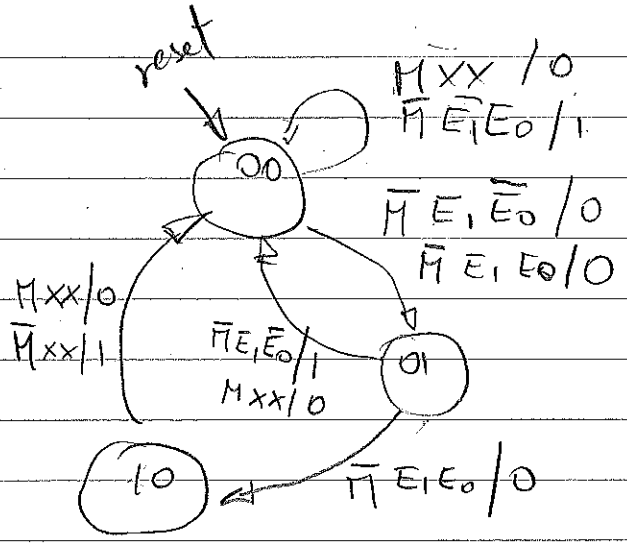
$E_1 E_0$ \ M	0	1
00	x	x
01	1	0
11	1	1
10	0	1

$$E_0^{t+1} = \overline{M} E_0 + M E_1$$

Máquina 3: Máquina que indica cuándo cuenta

Entradas $E_1 E_0$ estados máquina 2 } $M E_1 E_0$
M cambio modo

Salida C $C=1$ cuenta
$C=0$ no cuenta



Q_1	Q_0	M	E_1	E_0	Q_1^{t+1}	Q_0^{t+1}	C
0	0	0	0	1	0	0	1
0	0	0	1	0	0	1	0
0	0	0	1	1	0	1	0
0	0	1	0	1	0	0	0
0	0	1	1	0	0	0	0
0	0	1	1	1	0	0	0
0	1	0	0	1	x	x	x
0	1	0	1	0	0	0	1
0	1	0	1	1	1	0	0
0	1	1	0	1	0	0	0
0	1	1	1	0	0	0	0
0	1	1	1	1	0	0	0
1	0	0	0	1	0	0	1
1	0	0	1	0	0	0	1
1	0	0	1	1	0	0	1
1	0	1	0	1	0	0	0
1	0	1	1	0	0	0	0
1	0	1	1	1	0	0	0

$M = 0$

Q_1Q_0 \ E_1E_0	00	01	11	10
00	x	0	0	0
01	x	x	1	0
11	x	x	x	x
10	x	0	0	0

$M = 1$

Q_1Q_0 \ E_1E_0	00	01	11	10
00	x	0	0	0
01	x	0	0	0
11	x	x	x	x
10	x	0	0	0

$$Q_1^{t+1} = \bar{M} Q_0 E_0$$

$M=0$

Q_1Q_0 \ E_1E_0	00	01	11	10
00	X	0	1	1
01	X	X	0	0
11	X	X	X	X
10	X	0	0	0

$M=1$

Q_1Q_0 \ E_1E_0	00	01	11	10
00	X	0	0	0
01	X	0	0	0
11	X	X	X	X
10	X	0	0	0

$$Q_0^{t+1} = \bar{M}\,\bar{Q}_1\bar{Q}_0\,E_1$$

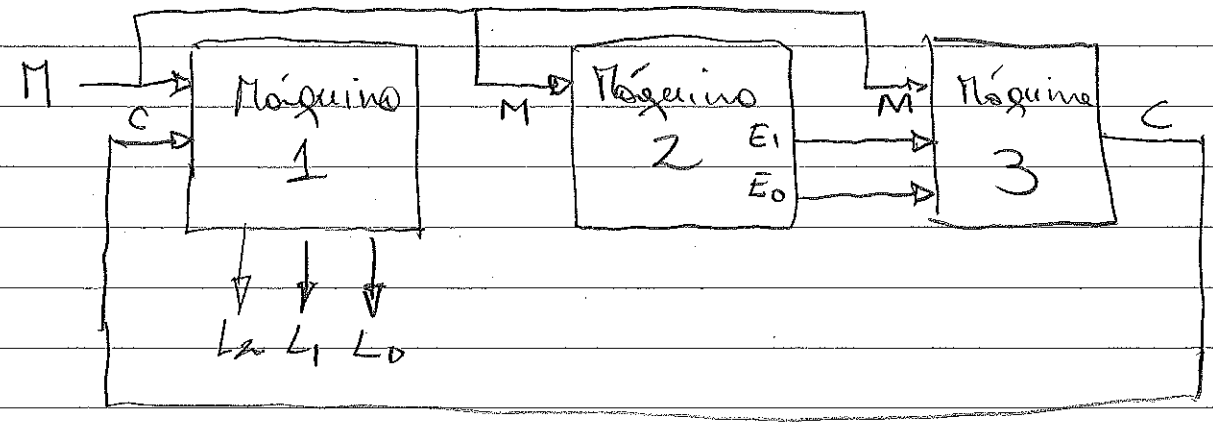
$M=0$

Q_1Q_0 \ E_1E_0	00	01	11	10
00	X	1	0	0
01	X	X	0	1
11	X	X	X	X
10	X	1	1	1

$M=1$

Q_1Q_0 \ E_1E_0	00	01	11	10
00	X	0	0	0
01	X	0	0	0
11	X	X	X	X
10	X	0	0	0

$$C = \bar{M}Q_1 + \bar{M}\,\bar{E}_1 + \bar{M}\,Q_0\,\bar{E}_0$$



Pregunta 4

Maquina 1

```
module maquina_1 (input clk,
                  input reset,
                  input C,
                  input M,
                  output [2:0] L);

reg [2:0] state, nextstate;
parameter S7 = 3'b111;
parameter S2 = 3'b010;
parameter S4 = 3'b100;
parameter S1 = 3'b001;
always @(posedge clk, posedge reset)
    if(reset) state <= S7;
    else state <= nextstate;

always @(*)

case (state)

S7: if (~C | M) nextstate = S7;
    else nextstate = S2;

S2: if (~C & ~M) nextstate = S2;
    else if (M) nextstate = S7;
    else nextstate = S4;

S4: if (~C & ~M) nextstate = S4;
    else if (M) nextstate = S7;
    else nextstate = S1;

S1: if (~C & ~M) nextstate = S1;
    else nextstate = S7;

endcase
```

```
assign L = state;

endmodule
```

Máquina 2

```
module maquina2 (input clk,
                 input reset,
                 input M,
                 output [1:0] E);

reg [1:0] state, nextstate;
parameter S1 = 2'b01;
parameter S2 = 2'b10;
parameter S3 = 2'b11;

always @ (posedge clk, posedge reset)
    if (reset) state <= S1;
        else   state <= nextstate;


always @(*)
  case (state)

    S1: if (M) nextstate = S2;
        else nextstate = S1;

    S2: if (M) nextstate = S3;
        else nextstate = S2;

    S3: if (M) nextstate = S1;
        else nextstate = S3;
  endcase
assign E = state;

endmodule
```

Maquina 3

```
module maquina_3 (input clk,
                  input reset,
                  input M,
                  input [1:0] E,
                  output C);

reg [1:0] state, nextstate;
parameter S0 = 2'b00;
parameter S1 = 2'b01;
parameter S2 = 2'b10;

always @ (posedge clk, posedge reset)
    if(reset) state <= S0;
      else    state <= nextstate;

always @ (*)

case (state)

S0: if ( M | ~M & ~E[1] & E0 ) nextstate = S0;
      else nextstate = S1;

S1: if ( ~M & E[1] & E[0]) nextstate = S2;
      else nextstate = S0;

S2:    nextstate = S0;
endcase

assign C = ~M & state[1] |
           ~M & E[1] |
           ~M & state[0] & ~E[0];

endmodule
```