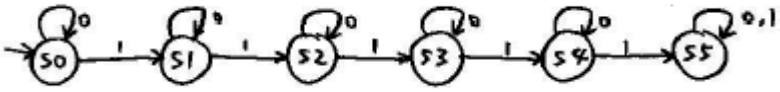
Cpr E 281 HW11 SOLUTION

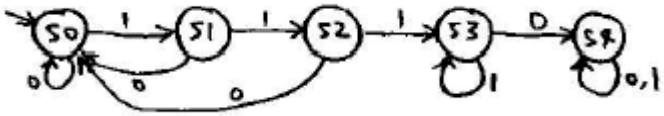
ELECTRICAL AND COMPUTER ENGINEERING
IOWA STATE UNIVERSITY

Synchronous Sequential Circuits
Assigned Date: Fourteenth Week
Due Date: First class of 15th week

P1. (a)

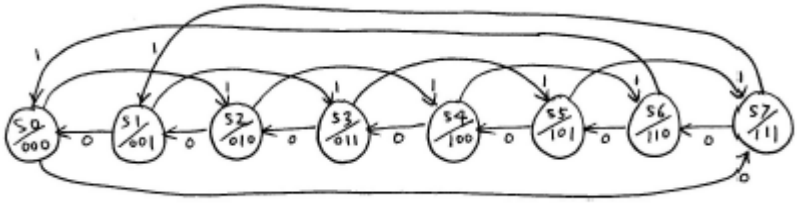


(b)



P2.

State transition diagram:



State table with a straightforward state assignment (000 for S0, 001 for S1, etc.):

Present state			Next state						Output		
			w=0			w=1					
y2	y1	y0	Y2	Y1	Y0	Y2	Y1	Y0	z2	z1	z0
0	0	0	1	1	1	0	1	0	0	0	0
0	0	1	0	0	0	0	1	1	0	0	1
0	1	0	0	0	1	1	0	0	0	1	0
0	1	1	0	1	0	1	0	1	0	1	1
1	0	0	0	1	1	1	1	0	1	0	0
1	0	1	1	0	0	1	1	1	1	0	1
1	1	0	1	0	1	0	0	0	1	1	0
1	1	1	1	1	0	0	0	1	1	1	1

The next-state expressions (inputs to D flip-flops) and output expressions are:

$$D_2 = Y_2 = w\,\bar{y}_2\,y_1 + \bar{w}\,y_2\,y_1 + w\,y_2\,\bar{y}_1 + \bar{w}\,y_2\,y_0 + \bar{y}_2\,\bar{y}_1\,\bar{y}_0\,w$$
$$D_1 = Y_1 = w\,\bar{y}_1 + \bar{y}_1\,\bar{y}_0 + \bar{w}\,y_1\,y_0$$
$$D_0 = Y_0 = \bar{y}_0\,\bar{w} + y_0\,w$$
$$z_2 = y_2$$
$$z_1 = y_1$$
$$z_0 = y_0$$

P3. The state table is:

Present state	Next state $w = 0$	Next state $w = 1$	Count
A	H	C	0
B	A	D	1
C	B	E	2
D	C	F	3
E	D	G	4
F	E	H	5
G	F	A	6
H	G	B	7

The state-assigned table is:

	Present state $y_2y_1y_0$	Next state $w = 0$ $Y_2Y_1Y_0$	Next state $w = 1$ $Y_2Y_1Y_0$	Output $z_2z_1z_0$
A	0 0 0	1 1 1	0 1 0	0 0 0
B	0 0 1	0 0 0	0 1 1	0 0 1
C	0 1 0	0 0 1	1 0 0	0 1 0
D	0 1 1	0 1 0	1 0 1	0 1 1
E	1 0 0	0 1 1	1 1 0	1 0 0
F	1 0 1	1 0 0	1 1 1	1 0 1
G	1 1 0	1 0 1	0 0 0	1 1 0
	1 1 1	1 1 0	0 0 1	1 1 1

The excitation table for T flip-flops is:

Present state $y_2y_1y_0$	Flip-flop inputs $w = 0$ $T_2T_1T_0$	Flip-flop inputs $w = 1$ $T_2T_1T_0$	Outputs $z_2z_1z_0$
000	111	010	000
001	001	010	001
010	011	110	010
011	001	110	011
100	111	010	100
101	001	010	101
110	011	110	110
111	001	110	111

The expressions for T inputs of the flip-flops are:

$T_2 = \overline{y_1} \cdot \overline{y_0} \cdot \overline{w} + y_1 \cdot w$,

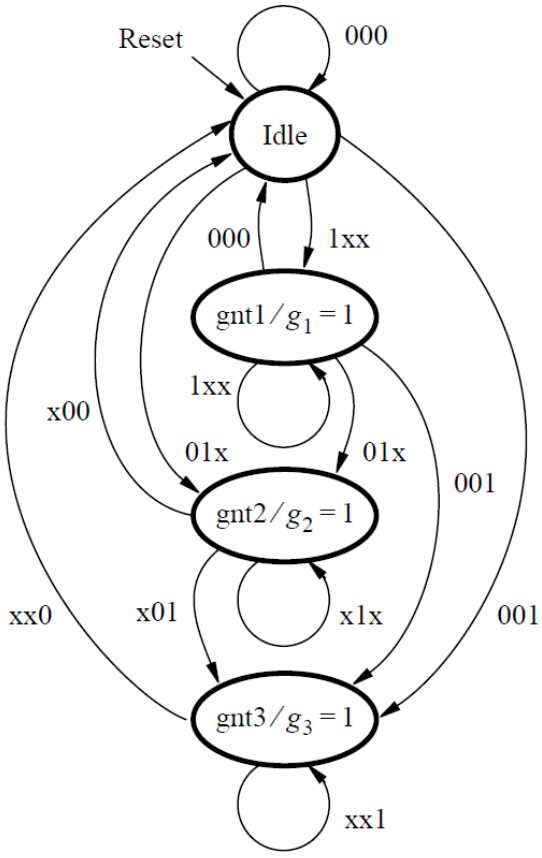
$T_1 = w + \overline{y_0}$

$T_0 = \overline{w}$

The outputs are:

$z_2 = y_2, z_1 = y_1, z_0 = y_0$.

P4. To ensure that Device 3 will get serviced the FSM in Figure 6.72 can be modified as follows:



P5. For the state table in Fig. 6.51, using a straightforward state assignment, we have:

	Present state $y_3y_2y_1$	Next state $w=0$ $Y_3Y_2Y_1$	Next state $w=1$ $Y_3Y_2Y_1$	Output z
A	0 0 0	0 0 1	0 1 0	1
B	0 0 1	0 1 1	1 0 1	1
C	0 1 0	1 0 1	1 0 0	0
D	0 1 1	0 0 1	1 1 0	1
E	1 0 0	1 0 1	0 1 0	0
F	1 0 1	1 0 0	0 1 1	0
G	1 1 0	1 0 1	1 1 0	0

$$
\begin{aligned}
Y_3 &= \overline{w}y_3 + \overline{y}_1y_2 + wy_1\overline{y}_3 \\
Y_2 &= wy_3 + w\overline{y}_1\overline{y}_2 + wy_1y_2 + \overline{w}y_1\overline{y}_2\overline{y}_3 \\
Y_1 &= \overline{y}_3\overline{w} + \overline{y}_1\overline{w} + wy_1\overline{y}_2 \\
z &= y_1\overline{y}_3 + \overline{y}_2\overline{y}_3
\end{aligned}
$$

For the state table in Fig. 6.52, using a straightforward state assignment, we have:

	Present state y_2y_1	Next state $w=0$ Y_2Y_1	Next state $w=1$ Y_2Y_1	Output z
A	0 0	0 1	1 0	1
B	0 1	0 0	1 1	1
C	1 0	1 1	1 0	0
F	1 1	1 0	0 0	0

$$
\begin{aligned}
Y_2 &= \overline{w}y_2 + \overline{y}_1y_2 + w\overline{y}_2 \\
Y_1 &= \overline{y}_1\overline{w} + wy_1\overline{y}_2 \\
z &= \overline{y}_2
\end{aligned}
$$

P6. A minimal state table is

Present state	Next State $w=0$	Next State $w=1$	Output z
A	A	B	0
B	E	C	0
C	D	C	0
D	A	F	1
E	A	F	0
F	E	C	1

b) An initial attempt at deriving a state table may be

Present state	Next state $w=0$	Next state $w=1$	Output z $w=0$	Output z $w=1$
A	A	B	0	0
B	D	C	0	0
C	D	C	1	0
D	A	E	0	1
E	D	C	0	0

States B and E are equivalent; hence the minimal state table is

Present state	Next state $w=0$	Next state $w=1$	Output z $w=0$	Output z $w=1$
A	A	B	0	0
B	D	C	0	0
C	D	C	1	0
D	A	B	0	1