Problem Set 9

9-3 An asynchronous sequential circuit is described by the following excitation and output functions:

$$Y = x_1x_2' + (x_1 + x_2')y$$

$$z = y$$

(a) Draw the logic diagram of the circuit.
(b) Derive the transition table and output map.
(c) Obtain a 2-state flow table.
(d) Describe in words the behavior of the circuit.

9-5 Convert the flow table of Fig. P9-5 into a transition table by assigning the following binary values to the states: $a = 00$, $b = 11$, and $c = 01$.
(a) Assign values to the extra fourth state to avoid critical races.
(b) Assign outputs to the don't-care states to avoid momentary false outputs.
(c) Derive the logic diagram of the circuit.

	x_1x_2 = 00	01	11	10
a	(a), 0	b, –	c, –	(a), 1
b	a, –	(b), 0	(b), 0	c, –
c	a, –	b, –	(c), 1	(c), 0

FIGURE P9-5

9-6 Investigate the transition table of Fig. P9-6 and determine all race conditions and whether they are critical or noncritical. Also determine whether there are any cycles.

y_1y_2	x_1x_2 = 00	01	11	10
00	10	(00)	11	10
01	(01)	00	10	10
11	01	00	(11)	(11)
10	11	00	(10)	(10)

FIGURE P9-6

9-12 Obtain a primitive flow table for a circuit with two inputs, x_1 and x_2, and two outputs, z_1 and z_2, that satisfy the following four conditions:

(a) When $x_1x_2 = 00$, the output is $z_1z_2 = 00$.
(b) When $x_1 = 1$ and x_2 changes from 0 to 1, the output is $z_1z_2 = 01$.
(c) When $x_2 = 1$ and x_1 changes from 0 to 1, the output is $z_1z_2 = 10$.
(d) Otherwise, the output does not change.

9-15 Assign output values to the don't-care states in the flow tables of Fig. P9-15 in such a way as to avoid transient output pulses.

	00	01	11	10
a	(*a*), 0	*b*, –	–, –	*d*, –
b	*a*, –	(*b*), 1	(*b*), 1	*c*, –
c	*b*, –	–, –	*b*, –	(*c*), 0
d	*c*, –	(*d*), 1	*c*, –	(*d*), 1

(a)

	00	01	11	10
a	(*a*), 0	*b*, –	*b*, –	(*a*), 0
b	*a*, –	(*b*), 0	(*b*), 1	*c*, –
c	*b*, –	*d*, –	(*c*), 1	(*c*), 1
d	(*d*), 0	(*d*), 1	*c*, –	*a*, –

(b)

FIGURE P9-15

9-18 Merge each of the primitive flow tables shown in Fig. P9-18.
Proceed as follows:

(a) Find all compatible pairs by means of an implication table.

(b) Find the maximal compatibles by means of a merger diagram.

(c) Find a minimal set of compatibles that covers all the states and is closed.

	00	01	11	10
a	(*a*), 0	*b*, –	–, –	*e*, –
b	*a*, –	(*b*), 0	*c*, –	–, –
c	–, –	*d*, –	(*c*), 0	*h*, –
d	*a*, –	(*d*), 1	–, –	–, –
e	*a*, –	–, –	*f*, –	(*e*), 0
f	–, –	*g*, –	(*f*), 0	*h*, –
g	*a*, –	(*g*), 0	–, –	–, –
h	*a*, –	–, –	–, –	(*h*), 0

(a)

	00	01	11	10
a	(*a*), 1	*f*, –	–, –	*e*, –
b	*c*, –	–, –	*j*, –	(*b*), 0
c	(*c*), 0	*d*, –	–, –	*b*, –
d	*c*, –	(*d*), 0	*g*, –	–, –
e	*a*, –	–, –	*g*, –	(*e*), 1
f	*a*, –	(*f*), 1	*g*, –	–, –
g	–, –	*d*, –	(*g*), 0	*k*, –
h	(*h*), 0	*d*, –	–, –	*k*, –
j	–, –	*f*, –	(*j*), 1	*b*, –
k	*a*, –	–, –	*j*, 1	(*k*), 0

(b)

FIGURE P9-18

9-19 (a) Obtain a binary state assignment for the reduced flow table shown in Fig. P9-19. Avoid critical race conditions.
(b) Obtain the logic diagram of the circuit using NAND latches and gates.

	x_1x_2 = 00	01	11	10
a	(a), 0	(a), 1	b, –	d, –
b	a, –	(b), 0	(b), 0	c, –
c	a, –	–, –	d, –	(c), 0
d	a, –	a, –	(d), 1	(d), 1

FIGURE P9-19

9-22 Find a circuit that has no static hazards and implements the Boolean function:

$$F(A, B, C, D) = \sum (0, 2, 6, 7, 8, 10, 12)$$

9-13 A traffic light is installed at a junction of a railroad and a road. The traffic light is controlled by two switches in the rails placed one mile apart on either side of the junction. A switch is turned on when the train is over it and is turned off otherwise. The traffic light changes from green (logic-0) to red (logic-1) when the beginning of the train is one mile from the junction. The light changes back to green when the end of the train is one mile away from the junction. Assume that the length of the train is less than two miles.
(a) Obtain a primitive flow table for the circuit.
(b) Show that the flow table can be reduced to four rows.

9-25 Complete the design of the circuit specified in Problem 9-13.