(d) The output z has the value 1 whenever the last four input symbols correspond to a BCD number that is a multiple of 3, i.e., 0, 3, 6, ...

Problem 9.6. Design a one-input one-output synchronous sequential circuit that produces an output symbol $z = 1$ whenever any of the following input sequences occurs: 1100, 1010, or 1001. The circuit resets to its initial state after an output symbol 1 has been generated.

(a) Form the state diagram or table. (Seven states are sufficient.)
(b) Choose an assignment, and show the excitation functions for JK flip-flops.

Problem 9.7. Design a one-input one-output synchronous sequential circuit that examines the input sequence in nonoverlapping strings having three input symbols each and produces an output symbol 1 that is coincident with the last input symbol of the string if and only if the string consisted of either two or three 1's. For example, if the input sequence is 010101110, the required output sequence is 000001001. Use SR flip-flops in your realization.

Problem 9.8. Design a modulo-8 counter that counts in the way specified in Table P9.8. Use JK flip-flops in your realization.

Table P9.8

Decimal	Gray code		
0	0	0	0
1	0	0	1
2	0	1	1
3	0	1	0
4	1	1	0
5	1	1	1
6	1	0	1
7	1	0	0

Problem 9.9. Construct the state diagram for a synchronous sequential machine that can be used to detect faults in coded messages of the 2-out-of-5 type. That is, the machine examines the messages serially and produces an output symbol 1 whenever an illegal message of five binary digits is detected.

Problem 9.10. When a certain serial binary communication channel is operating correctly, all blocks of 0's are of even length and all blocks of 1's are of odd length. Show the state diagram or table of a machine that will produce an output symbol $z = 1$ whenever a discrepancy from the above pattern is detected. The following is an example.

$$\begin{array}{lcccccccccccccccc} X: & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 0 & \cdots \\ Z: & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & \cdots \end{array}$$

Problem 9.11. A new kind of flip-flop has been designed. It is equivalent to an SR flip-flop with gated inputs, as shown in Fig. P9.11.

A synchronous sequential circuit that generates an output symbol $z = 1$ whenever the string 0101 is scanned in the input sequence is to be designed. Overlapping strings

Fig. P9.13

$t =$	0	1	2	3	4	5	6	7	8	9	10	11	12 ...
$x(t) =$	0	1	1	1	0	0	1	1	0	0	0	1	0 ...
$z(t) =$	0	1	1	1	0	0	0	1	0	0	0	1	1 ...
	(a)			(b)							(a)		

Problem 9.14. The synchronous circuit shown in Fig. P9.14, where D denotes a unit delay, produces a periodic binary output sequence. Assume that initially $x_1 = 1$, $x_2 = 1$, $x_3 = 0$, $x_4 = 0$ and that the initial output sequence is 1100101000. Thereafter, this sequence repeats itself. Find a minimal expression for the combinational circuit $f(x_1, x_2, x_3, x_4)$.

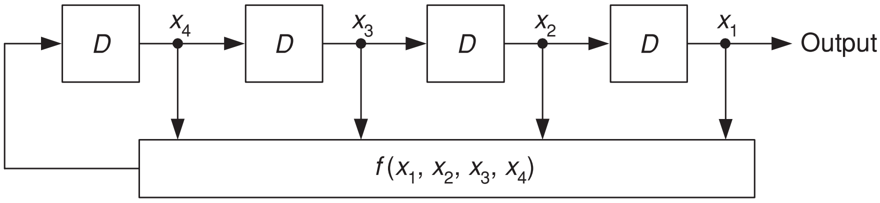

Fig. P9.14

Problem 9.15. A synchronous machine N is part of a transmitter and is used to encode binary serial messages. The coded messages are then transmitted to a receiver, as shown in Fig. P9.15. The receiver contains a synchronous machine M that is used to decode the received messages.

(a) Given that the initial state of N is A, find the state diagram of machine M.

(b) Suppose the initial state of N is unknown and machine M received a 10-bit message; which of the 10 bits can be uniquely decoded without an error? Explain.

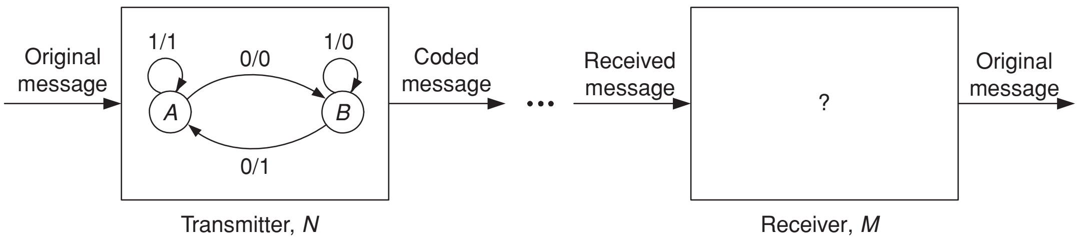

Fig. P9.15

Problem 9.16. A *palindrome* is a sequence which reads the same backward as forward, e.g., 11011 or 01010. Show the finite-state control of a Turing machine that is capable of detecting arbitrarily long palindromes. Assume that you are given a tape initially marked only with symbols #, 0, 1, where the blanks (#) separate blocks of intermixed 0's and 1's. The machine will be started on a # and then checks whether the sequence to its right is a palindrome. If not, the machine should proceed to the next block. If the sequence is a palindrome, the machine should stop at the # to the right of the block. An example is shown in Fig. P9.16.