QUESTION 1

Theme: Multiplier, VHDL

(a) You are provided with the following devices:
- plenty of AND gates
- three units of 4-bit ripple carry adder

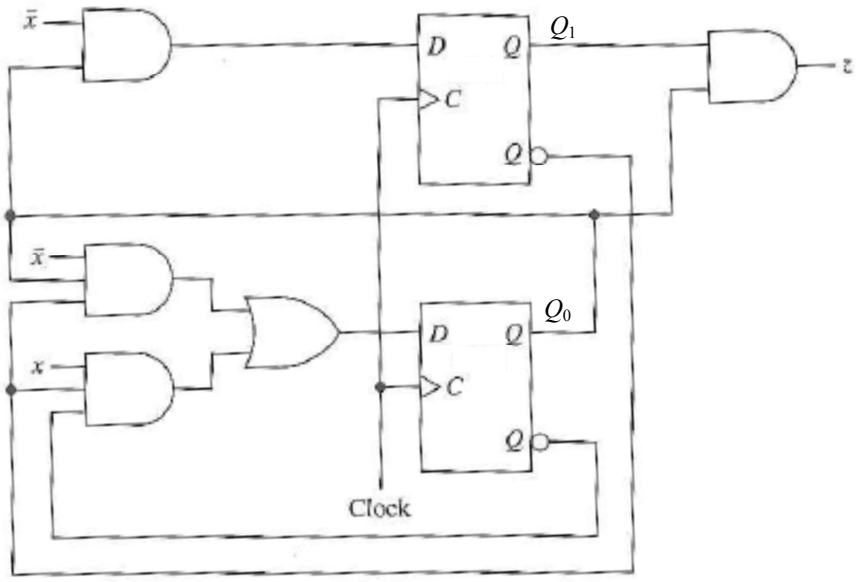
Build a 4-bit multiplier by using the provided devices only.

(b) Suppose that the * operator is not available in the VHDL library. How do you write the VHDL code to construct a 4-bit multiplier?
[*Hint*: Use AND and + operators]

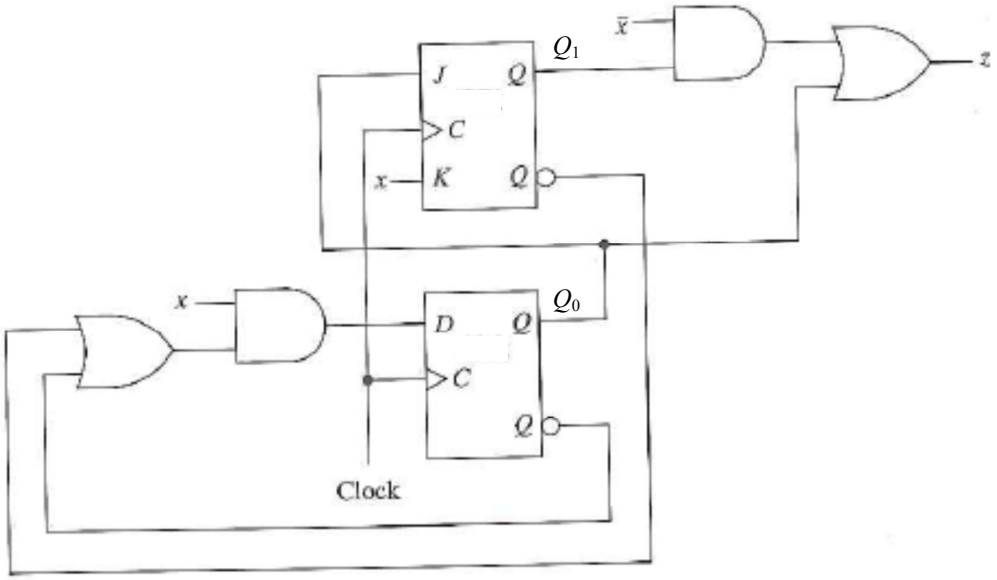
QUESTION 2

Theme: Reverse engineering FSM

For the circuits shown in Figures (a) and (b), construct the state transition tables and the state diagrams. The states are defined by Q_1Q_0.



(a)



(b)

QUESTION 3

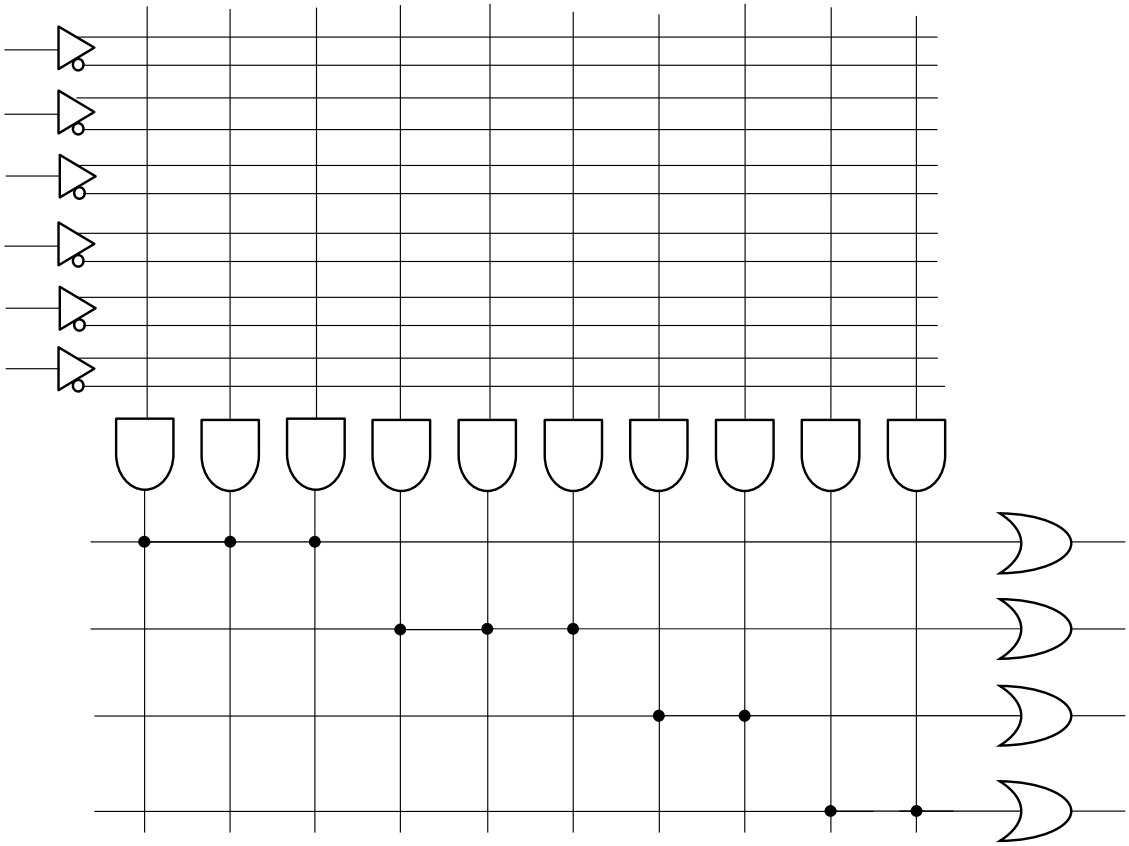
Theme: PAL, K-map

Use the given PAL device to realize the following functions:

$$P(A,B,C,D) = \sum m(1,4,5,7,13)$$

$$Q(A,B,C,D) = \sum m(0,4,7,10,13,14,15)$$

$$R(A,B,C,D) = \sum m(7,13,15)$$



QUESTION 4

Theme: Sequence detector

A finite state machine has one input and one output. The output becomes 1 (high) when a 0 has been seen between two 1s or a 1 has been seen between two 0s in the input sequence. Assuming this is to be implemented as a Moore machine, draw a state diagram and implement the circuit by using JK flip-flops.

QUESTION 5

Theme: Counter

(a) Construct a 3-bit counter that will count up according to Gray code when the input is high and unchanged when the input is low. Use the 3-bit Gray code sequence as: 000, 001, 011, 010, 110, 111, 101, 100 and repeat.

(b) Construct a 4-bit Johnson counter. The counter sequences through the states 1000, 1100, 1110, 1111, 0111, 0011, 0001, 0000 and repeat.