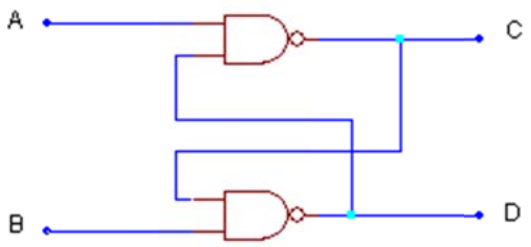
1. Explain with a characteristic table, the operation of the circuit below.



   Suggest a practical use for this circuit and explain how it operates.
   Draw a similar circuit that will have active 'high' inputs and draw its characteristic table.

2. Design a Moore type finite state machine that gives an output of 1 if and only if a serial input data stream has been '1' for at least three consecutive clock cycles. It should not reset after finding a valid sequence.

3. Draw the circuit for a 4-bit shift register using D-Type flip-flops. Assuming that the initial state of the flip-flops is unknown, show how the register could be loaded in a serial manner, to "1010". (Draw a table of register values for each clock edge). Show how a 2-to-1 multiplexer could be used on each D input to enable a parallel load of "1010". What is the advantage of having a parallel load? This arrangement could now be used to load up parallel data and transmit it serially. Explain the difference between serial and parallel transmission of data.

4. Design a sequential circuit that will convert any 3-bit binary code to Gray code, using only one XOR gate and a shift register. The input binary code is held initially in the shift register, to be replaced eventually by the Gray code. Assume that a suitable clock line is available, and make clear how many clock pulses are needed for correct operation of your circuit. Briefly explain its operation.
   (hint: A xor 0 = A)

5. Exam type sequential logic question:

   A certain synchronous state machine can exist in four states, denoted in turn **A**,**B**,**C**,**D** and it has a one-bit output line. Find and draw the state diagram for the system if it starts in state **A** and gives an output of logic '1' immediately if (and only if) the bit pattern 0100 is detected anywhere in a serial input bit sequence $b_0b_1b_2b_3\ldots$ (where one bit b_n is input at each rising edge of the clock). Once the full sequence 0100 has been detected, the system must be able to detect the full 4-bit sequence 0100 again, starting with the next input bit.
   Design the simplest practical circuit you can for this synchronous system, using only two D-type flip-flops plus some simple combinatorial gates.