Quiz-1: EC2.201-VLSI Design (Monsoon 2021)

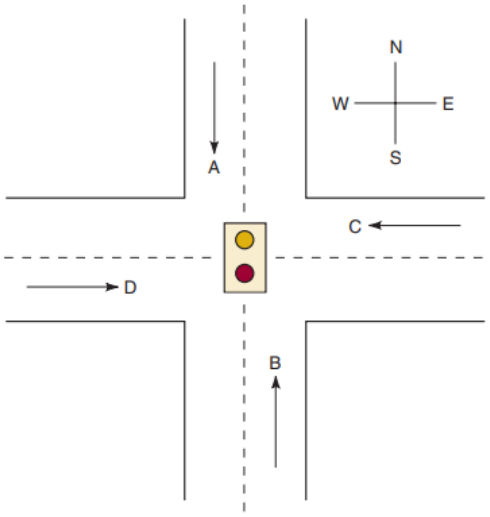
Max. Time: 45 Mins [9:05 to 09:50 AM] Date: 16/09/2021

NOTE: Attempt any 3 questions
No query will be entertained during quiz.

Q 1. In digital systems, it is often necessary to have circuits that can shift the bits of a vector by one or more-bit positions to the left or right. We need a circuit that can shift right, and the bits that are shifted out are placed into the vacated positions on the left. Design a 4-bit circuit that rotates vector V = v3 v2 v1 v0 by 0, 1, 2, or 3-bit positions as determined by the value of two control signals s0 and s1. Let the output of the circuit be a 4-bit value Y = y3 y2 y1 y0. Use MUXs to design the circuit. [10 Marks]

Q 2. Figure below shows the intersection of a 4-lane road which intersects at the middle. Vehicle-detection sensors are placed along lanes C and D (main road) and lanes A and B (access road). These sensor outputs are LOW (0) when no vehicle is present and HIGH (1) when a vehicle is present. The intersection traffic light is to be controlled according to the following logic: [10 Marks]

i. The east-west (E-W) traffic light will be green whenever both lanes C and D are occupied.
ii. The E-W light will be green whenever either C or D is occupied but lanes A and B are not both occupied.
iii. The north-south (N-S) light will be green whenever both lanes A and B are occupied but C and D are not both occupied.
iv. The N-S light will also be green when either A or B is occupied while C and D are both vacant.
v. The E-W light will be green when no vehicles are present.



Using the sensor outputs, A, B, C, and D as inputs, design a logic circuit to control the traffic light. There should be two outputs, N-S and E-W, that go HIGH when the corresponding light is to be green. Simplify the circuit as much as possible and show all steps

a) Implement the circuit using only UNIVERSAL GATES (you can use multiple inputs universal gates). You can assume input and its inverted version are already available. (i.e., both A and A' are already available with you)

b) Implement all the expression obtained using multiplexer. One implementation only using (8x1 mux and 2X1 mux) and other implementation using (4X1 mux and 2x1). You can assume input and its inverted version are already available (i.e., both A and A' are already available with you)

Q 3. Design a circuit that operates a safety alarm in a car to ensure seatbelts are fastened and doors are locked. Whenever the driver and/or passenger seats are occupied and the seatbelts are not fastened when the car's Ignition is on, it will sound an alarm. Also, if the seats are occupied and doors are not closed properly while the ignition is on, it will sound an alarm. That is alarm is on when- [10 Marks]

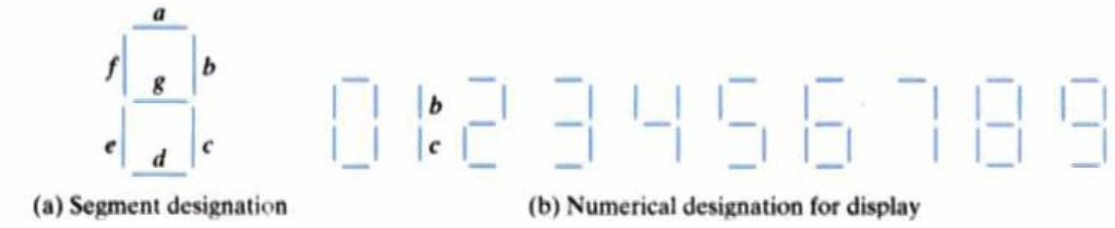
a) Driver seat is occupied, ignition is on, and seatbelt is not fastened, but all the doors are locked properly.
b) Driver seat is occupied, ignition is on, and seatbelt is not fastened, but one or many doors are not locked properly.
c) Driver seat is occupied, ignition is on, and seatbelt is fastened, but one or many doors are not locked properly.
d) Driver and Passenger seats are occupied, and ignition is on and seatbelts of either driver or passenger or both are not fastened but all the doors are locked properly.
e) Driver and Passenger seats are occupied, ignition is on and seatbelts of either driver or passenger or both are not fastened but one or many doors are not locked properly.
f) Driver and Passenger seats are occupied, ignition is on and seatbelts of both are fastened but one or many doors are not locked properly.

(Note - Take the output as don't care when ignition is on, driver seat is unoccupied and passenger seat is occupied)

Q 4. It's the auspicious day of Ganesh Chaturthi and Chandu is very excited as this time he is celebrating it without lockdown this year. Everyone in his locality have collected funds and organized the festival in a grand way. They have also set up a ladoo counter so that all the devotees can have the prasad (sacrament/boon/dainty/blessed food) after darshan. In order to keep track of number of ladoo's sold they have arranged a counter that counts the number of ladoo's sold. But unfortunately, the counter gives the value in 4-bits (BCD-XXXX): (. Everyone approached Chandu to help them in converting this 4-bit value into number display (seven–segment display). Chandu is very much confused in how to resolve this issue. He e has approached you to help him.

Chandu has offered help by collecting the data regarding seven segment displays. The figure for it is shown below. It shows how a seven-segment display looks like – it has 7 bits (a, b, c, d, e, f, g) which are given the values (HIGH and LOW), based on the combination of these values we get the corresponding number displayed.

You being his friend need to help him resolve this by designing a combinational circuit that takes in a 4-bit input from the counter and then displaying the number in a seven-segment display. [10 Marks]



(a) Segment designation (b) Numerical designation for display