**SOLUTIONS**

**EBU4202 Mock Class Test/Tutorial 22 March 2019 (E-Commerce)/12 April (IoT)**

**Question 1**

i) In the context of digital circuit devices, briefly explain the meaning of each of the terms "fan-out", "power dissipation" and "propagation delay". [3 marks]

ii) Using a suitable diagram, explain what are $V_{ILmax}$, $V_{IHmin}$, $V_{OLmax}$ and $V_{OHmin}$, what is meant by the term "Low Level Noise Margin" and "High Level Noise Margin". [6 marks]

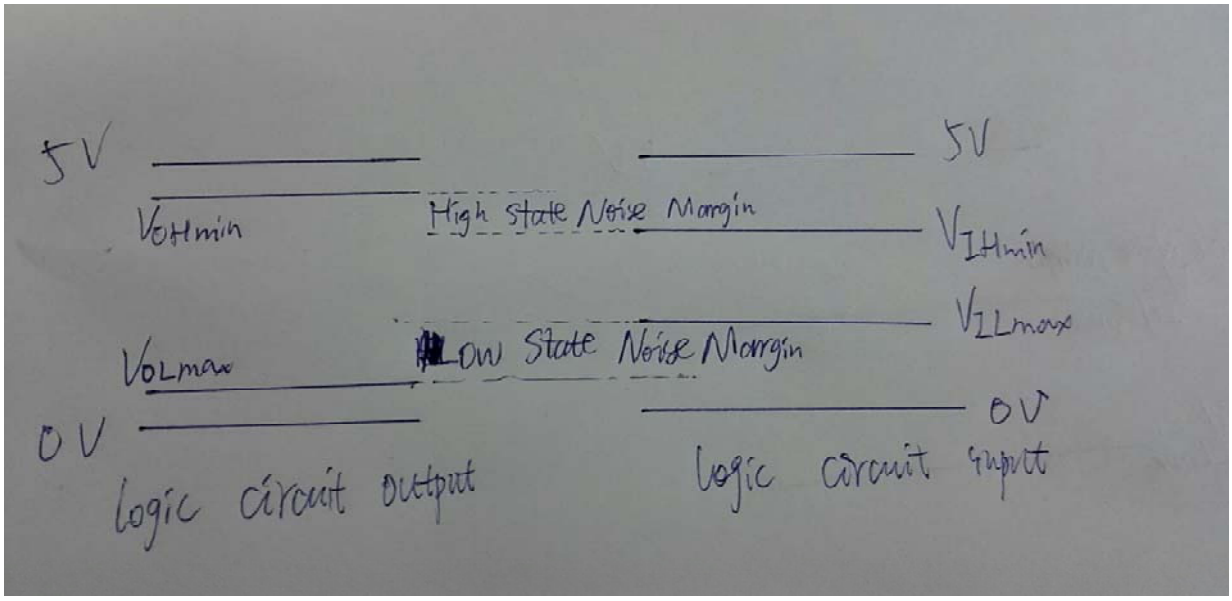
iii) State what is meant by the terms "Positive Logic" and "Negative Logic". [2 marks]

**Answers:**

i) fan-out: the number of device inputs that a device output can be connected to without the voltage being outside the range for a valid logic level [1 mark]

Power dissipation: the power consumed from the power supply by the logic device [1 mark]

Propagation delay: the time taken from a change of logic level at the input of a logic device to a change at the output of the device [1 mark]




ii)

[2 mark] for the diagram

$V_{ILmax}$ denotes the maximum input voltage that can be recognized as a low state; [1 mark]

$V_{IHmin}$ denotes the minimum input voltage that can be recognized as a high state; [1 mark]

$V_{OLmax}$ denotes the maximum output voltage in the low state;[1 mark]

$V_{OHmin}$ denotes the minimum output voltage in the high state; [1 mark]

The low level noise margin is the difference between $V_{OLmax}$ and $V_{ILmax}$ (or $V_{OLmax}$- $V_{ILmax}$) [1 mark]

The high level noise margin is the difference between $V_{OHmin}$ and (or $V_{IHmin}$-$V_{OHmin}$) [1 mark]

iii) In positive logic, low is 0 and high is 1. In negative logic, low is 1 and high is 0. [2 mark]

**Question 2**

Let ABCD represent a 4 bit BCD number.

i) Draw the truth table for a combinational logic circuit that produces a '1' output when the input ABCD is either a prime number or a perfect square. The input combination 0000 is not allowed to occur. (A prime number is a number that can only be divided by itself or 1.) [5 marks]

ii) Draw the Karnaugh map for this circuit and show the prime implicants. [5 marks]

iii) From the Karnaugh map, determine a minimal expression for the output expressed in SoP form. [2 marks]

iv) Using a truth table, show the state of the output for each of the "can't happen" input states as a result of the minimisation. [1 mark]

v) Draw the circuit diagram for the minimal SoP implementation of the function.

[2 marks]

vi) Convert the logic function to all NAND form and draw the circuit diagram.

[4 marks]

**Answers**

i) BCD is the range 0 to 9 where 10 to F do not occur [1 mark]

Prime numbers are 1, 2, 3, 5, 7 [1 mark]

Perfect squares are 1, 4, 9 [1 mark]

The truth table is:

| A | B | C | D | F(A,B,C,D) |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | X |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | X |
| 1 | 0 | 1 | 1 | X |
| 1 | 1 | 0 | 0 | X |
| 1 | 1 | 0 | 1 | X |
| 1 | 1 | 1 | 0 | X |
| 1 | 1 | 1 | 1 | X |

[2 marks for correct truth table]

ii) The Karnaugh map is:

| AB | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| CD | | | | |
| 00 | X | 1 | X | 0 |
| 01 | 1 | 1 | X | 1 |
| 11 | 1 | 1 | X | X |
| 10 | 1 | 0 | X | X |

[5 marks: 2 marks for correct map, 1 for each correct prime implicant]

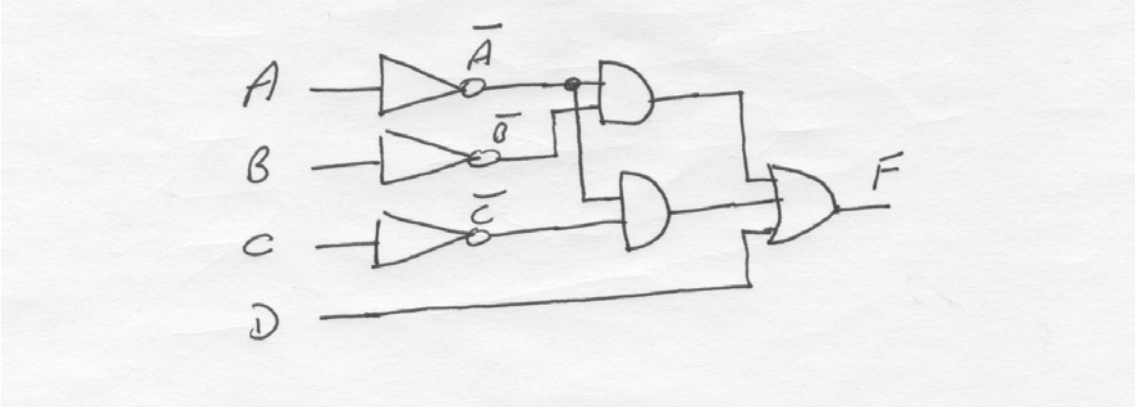
iii) A minimal expression is: F=A′.C′+A′.B′+D [2 marks]

iv) The resulting output states are:

| A | B | C | D | F(A,B,C,D) |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 1 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

[1 mark]

v) The circuit diagram is:



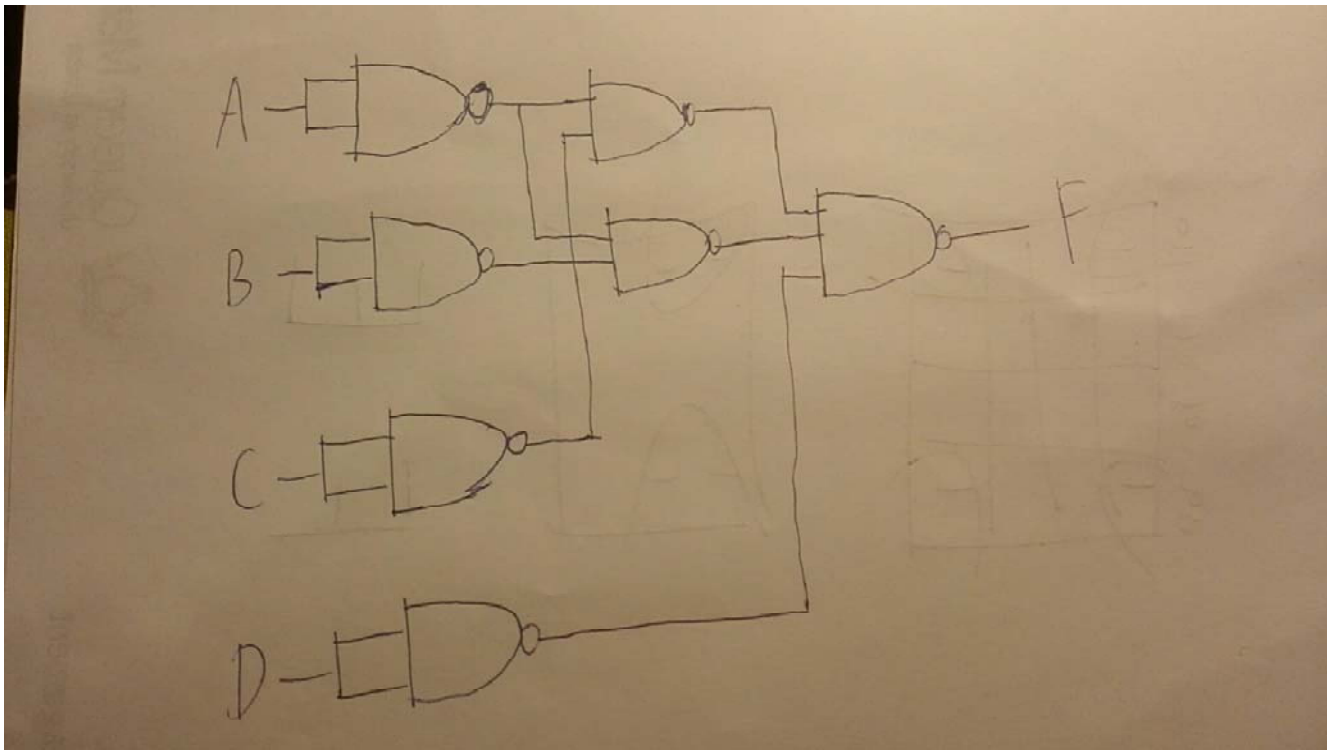

[2 marks]

vi) Using De Morgan's Theorem, the all NAND form is:

F = [(A'.C')'.(A'.B')'.D']' [2 marks]

Circuit diagram:

[2 marks]


A
B
C
D
F