SAMPLE TEST QUESTIONS - ANSWERS

1. Using 9-bit binary plus a sign bit, the base-10 number +338 is represented by:

(a) 1011010010

(b) 0101010010

(c) 0011010011

(d) 1011001001

S	256	128	64	32	16	8	4	2	1
0	1	0	1	0	1	0	0	1	0

2. Using 7-bit binary plus a sign bit, the 1's complement representation of the binary for -73 is:

(a) 00110110

(b) 10110101

(c) 10110111

(d) 10110110

S	64	32	16	8	4	2	1	
1	1	0	0	1	0	0	1	binary
1	0	1	1	0	1	1	0	1's comp

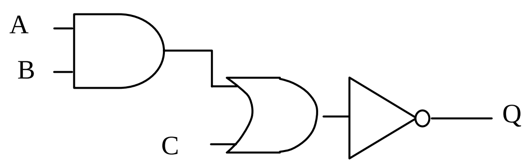
3. The logic gate combination on the right represents the Boolean expression:

(a) $\overline{(A.B)+C}$

(b) $\overline{A.(B+C)}$

(c) $(A.B) \oplus C$

(d) $A . (B \oplus C)$



4. Select the truth table which corresponds to the Boolean expression $\overline{(A+B)}$.:

(a)

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	0

(b)

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	1

(c)

A	B	Q
0	0	1
0	1	0
1	0	0
1	1	0

(d)

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

5. Use 2's complement addition, representing numbers with 7-bits plus a sign bit, to perform the subtraction 76 - 119.

	S	64	32	16	8	4	2	1
+76 in binary	**0**	**1**	**0**	**0**	**1**	**1**	**0**	**0**
- 119 in binary	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**1**
- 119 in 1's comp	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**0**
- 119 in 2's comp	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**1**

So sum is:

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    0 1 0 0 1 1 0 0
+   1 0 0 0 1 0 0 1
    1 1 0 1 0 1 0 1
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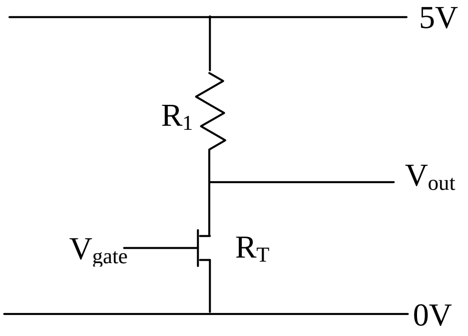
Sign bit is 1 so : (i) answer is negative
(ii) answer is in 2's comp

2's comp	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**
1's comp	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**0**
binary	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**1**

This is: -(32 + 8 + 2 +1) = -43

6. The diagram on the right illustrates the use of a transistor as a switch in an electrical circuit (i.e. the use of the gate voltage V_{gate} applied to the transistor to control the output voltage V_{out}. Explain briefly how this is done and why using a transistor as a switch is preferable to having a mechanical switch.



When a HIGH voltage is applied to the gate terminal of a MOSFET transistor the resistance across the transistor (R_T) is small. When a LOW voltage is applied to the gate R_T is very large.

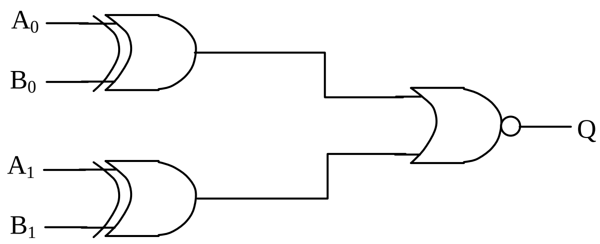
R_1 and R_T act as a potential divider.

If $R_1 >> R_T$ then the voltage across R_1 is much larger than that across R_T. As the total voltage across R_1 and R_T combined is 5 V, this means that V_{out} (voltage across R_T) ≈ 0 V.

If $R_1 << R_T$ then the voltage across R_1 is much less than that across R_T. This means that V_{out} ≈ 5 V.

Thus making V_{gate} = HIGH makes V_{out} = LOW and when V_{gate} = LOW, V_{out} = HIGH.

7. Explain briefly the operation of the combinational logic circuit shown below.



The top XOR gate has an output of 1 if $A_0 \neq B_0$.

The lower XOR gate has an output of 1 if $A_1 \neq B_1$.

The NOR gate will have an output of 1 only if the outputs of both the XOR gates are 0.

Thus Q will be 1 ONLY if $A_0 = B_0$ and $A_1 = B_1$.

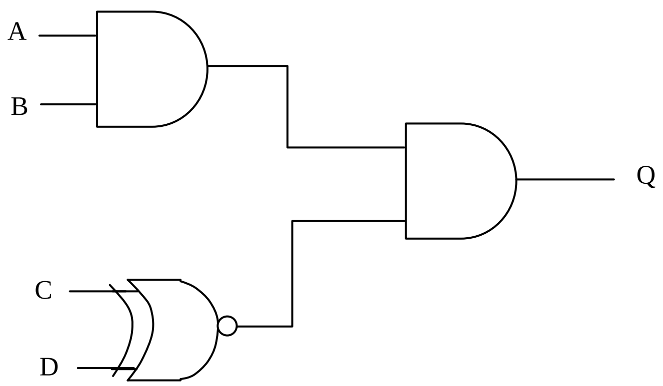
Thus the circuit tests for $A_0 = B_0$ AND $A_1 = B_1$.

8. Design a logic circuit whose output is HIGH whenever A and B are both HIGH as long as C and D are either both HIGH or both LOW.

A gate that gives a 1 when only both its inputs are 1 is and AND gate.

A gate that gives a 1 when either both inputs are 1 or both inputs are 0 is an XNOR gate (XOR gate followed by a NOT gate).

If both these conditions are to be met the outputs must go into a second AND gate.



In terms of Boolean algebra: $\mathbf{AB\overline{(C \oplus D)} = Q}$