12th Annual International Microelectronics Olympiad of Armenian

T E S T

The participants shall select one answer out of 5 possible answers in the answer sheet for each question (A, B, C, D, E) by crossing lines from the top left corner to the bottom right corner and form the bottom left corner to the top right corner (as it is shown below).

8.	A	B	C	D	E

In the case of crossing out more than one answer for the same question or making any other notes, the answer to that question will be scored 0.

8.	A	B	C	D	E

Participant _____

1. Considering that XOR2 cell's inputs are independent and equally distributed, which is the probability of output switching?
   A. *0.25*
   B. *0.375*
   C. *0.5*
   D. *0.75*
   E. *0.875*

2. The threshold voltage of a MOS transistor is the dependence of:
   A. *Channel length*
   B. *Body doping degree*
   C. *Drain and source diffusion depth*
   D. *Gate voltage*
   E. *Drain voltage*

3. Before reading from 1T DRAM cell, the bitline BL must:
   A. *Discharge to VSS*
   B. *Discharge to V_t*
   C. *Charge to VDD*
   D. *Charge to VDD-V_t*
   E. *Charge to VDD/2*

4. Denote by φ the set of all possible single stuck-at-0 and stuck-at-1 faults on input and output lines of logical V ("OR"), & ("AND") ^("NEGATION"). For any fault F ∈ φ, denote by T(F) the set of all input ("test") patterns detecting F. It is said for any two faults Fi, Fj ∈ φ that they are equivalent if:
   A. *$T(Fi) \cap T(Fj) = \varnothing$*
   B. *$T(Fi) = T(Fj)$*
   C. *$T(Fi) \subseteq T(Fj)$*
   D. *$T(Fj) \subseteq T(Fi)$*
   E. *The correct answer is missing*

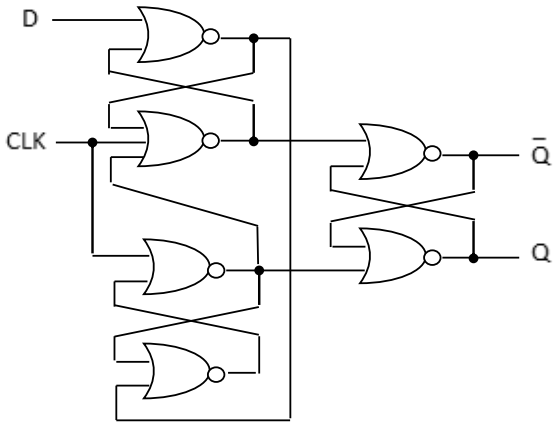
5. Which circuit corresponds to the following description in SystemVerilog?

```
module comb(input logic [3:0] a,
output logic [3:0] y);
always @(a)
casez(a)
4'b1???: y <= 4'b1000;
4'b01??: y <= 4'b0100;
4'b001?: y <= 4'b0010;
4'b0001: y <= 4'b0001;
```

default: y <= 4'b0000;
endcase
endmodule

A. *Priority circuit*
B. *Priority encoder*
C. *Decoder*
D. *Demultiplexer*
E. *The correct answer is missing*

6. What kind of flip-flop is shown in the figure below?



A. *Positive edge triggered D flip-flop*
B. *Negative edge triggered D flip-flop*
C. *Positive edge triggered J-K flip-flop*
D. *Negative edge triggered T flip-flop*
E. *The correct answer is missing*

7. Define FSM with 16 states. How many internal variables (bits) are required for "almost one-hot" state assignment?

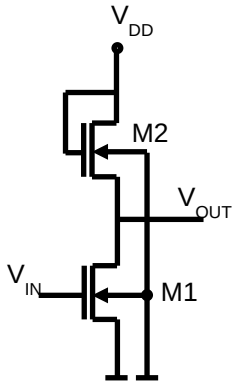
A. *16*
B. *4*
C. *15*
D. *17*
E. *The correct answer is missing*

8. The IC ROM 64Kx16 keeps a table of multiplying 8-bit unsigned integer numbers. Which number will be written in the cell with address 2313? The answers are presented in the decimal system.

A. *120*
B. *81*

C. *35*
D. *80*
E. *The correct answer is missing*

9. How will the small signal amplification coefficient of an amplifier change if the channel width of M2 transistor is doubled?



A. *It is shared, too*
B. *It doubles*
C. *It becomes a little less than half*
D. *It increases by more than 2 times*
E. *It becomes a little more than half*

10. What is the difference between the cascode amplifier with the same R_D load resistor and same transistors and a simple amplifier with Common source connectivity?

A. *Larger gain coefficient*
B. *Higher frequency*
C. *Smaller range of output signal change*
D. *All the preceding answers are correct*
E. *The first two answers are correct*

11. What does not the common mode output voltage of a differential amplifier with a diode connection load depend on?

A. *Common input voltage*
B. *Diode connected transistor dimensions*
C. *DC (Iss)*
D. *A and B answers are correct*
E. *B and C answers are correct*

12. How many operational amplifiers are there in a pipelined ADC of 10-bit 1.5 bit/cascade structure?

A. *10*

B. 20
C. 18
D. 9
E. 11

13. How to form countervailing components of gate current in field transistors with p-n junction?

A. Increasing the gate surface
B. Neutralization of channel charges
C. Increasing minority charges
D. A. and C. answers are correct
E. Inhomogeneous change of height along the barrier of p-n junction by external affect

14. By how many types of charge carriers is the photocurrent conditioned in photodiode when the beam is absorbed in p – domain and intrinsic absorption occurs?

A. By two types of charge carriers
B. Only by electrons
C. Only by holes
D. A. and C. answers are correct
E. All the answers are wrong

15. The output operation of a semiconductor is smaller than the operation of metal output. What kind of contact will occur between them?

A. Opening contact
B. Closing contact
C. High conductance contact
D. A. and C. answers are correct
E. All the answers are wrong

16. How does the width of semiconductor's band-gap energy change from the increase of energy?

A. It increases
B. It decreases
C. It does not change
D. It depends on the type of semiconductor conductance
E. It depends on the geometrical dimension of semiconductor

17. As the effective mass of electrons usually higher or smaller than the effective mass of holes?

A. It is higher
B. It is sharply higher
C. It is smaller
D. It is sharply smaller
E. They are equal to each other

18. What is the volume of the Brillouin first zone in k- space for a simple cubic crystal?

A. $V_B^{(k)} = \left(\frac{2\pi}{a}\right)^5$

B. $V_B^{(k)} = \left(\frac{2\pi}{a}\right)^4$

C. $V_B^{(k)} = \left(\frac{2\pi}{a}\right)^3$

D. $V_B^{(k)} = \left(\frac{2\pi}{a}\right)^2$

E. The correct answer is missing

19. In what modes can field-effect transistors work?

A. Cut-off, linear and saturation
B. Passive, active and breakdown
C. Hole and breakdown
D. Avalanche breakdown and passive
E. Active and reverse

20. The number of different masks, for forming a semiconductor integrated circuit is determined by:

A. Mutual consent of the designer and manufacturer
B. The number of simultaneously processed semiconductor crystals
C. The number of topological layers that are successively formed in a crystal
D. Mass production
E. Design rules

21. The number of different masks for forming a semiconductor integrated circuit is determined by:

A. The minimum geometric size of the element that is being formed
B. The number of topological layers
C. The cost of designing and making masks
D. The type of photoresist that is used
E. Mutual consent between the customer and designer

22. What function coincides with the function

$$f(\mathrm{x}) = 2\arctan \mathrm{x} + \arcsin\frac{2x}{1+x^2}$$

for x > 1?

A. $y = x - \pi$

B. $y = \pi + x$

C. $y = \pi \arctan(3\mathrm{x})$

D. $y = \pi - \arctan(3\mathrm{x})$

E. $y = \pi$

23. Calculate the number of the real roots (multiplicity is taken into account) of the function

$$f(x) = xe^{-x} + e^{-x} + 0.5x^2 - 1.$$

A. 1
B. 2
C. 3
D. 4
E. 5

24. Calculate

$$\lim_{n\to\infty} \begin{pmatrix} \cos\alpha & -\sin\alpha \\ \sin\alpha & \cos\alpha \end{pmatrix}^n, \text{ where } \alpha = \pi\left(\sqrt{n^2+4} - \sqrt{n^2+2}\right).$$

A. $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$
B. $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$
C. $\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$
D. $\begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$
E. $\begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$

25. The increase of duplication of logic organization of scheme leads to:

A. Decrease of performance
B. Increase in the number of external pins
C. Decrease in the number of logic elements
D. Decrease in the number of logic outputs
E. Decrease in the number of logic inputs

26. Which of the mentioned answers provides performance increase of logic cells?

A. Decrease of load capacitance
B. Increase of threshold voltage
C. Decrease pf supply voltage
D. Increase of load capacitance
E. The correct answer is missing

27. Which of the following code examples outputs the following text?

1234
234
34
4

A.

```
for (int i = 1; i <= 4; i = i+1)
{
    for (int j = 1; j <= i; j = j+1)
    {
        Console.Write(i);
    }
    Console.WriteLine();
}
```

B.

```
for (int i = 1; i <= 4; i = i+1)
{
    for (int j = i; j <= 4; j = j+1)
    {
        Console.Write(i);
    }
    Console.WriteLine();
}
```

C.

```
 for (int i = 1; i <= 4; i = i+1)
{
    for (int j = 1; j <= i; j = j+1)
    {
        Console.Write(j);
    }
    Console.WriteLine();
}
```

D.

```
  for (int i = 1; i <= 4; i = i+1)
  {
      for (int j = i; j <= 4; j = j+1)
      {
```

```
            Console.Write(j);
        }
        Console.WriteLine();
    }
```

E. None of the above

28. An array x contains the following values. What will be the value of m after the code example is executed?

1	6	8	1	15	2

```
int n = 6;
int m = 0;
for (int i = 1; i <= n - 1; i = i + 1)
{
    if (x[i] > x[i - 1])
    {
        m = m + 1;
    }
}
```

A. 1
B. 2
C. 3
D. 4
E. 5

29. What is true b after this code executes, if a>0?

```
int b = 0;
while (b < a)
{
    b = b + 9;
}
```

A. b must be less than a
B. b must be greater than a
C. b may be equal to a + 9
D. b must be greater than 0
E. b may be equal to a

30. The array data contains the following:

1	2	3	4	5	6	7	8	9	10

What will be the value of array data ater the give code executed?

```
for (int i = 4; i < 10; i++)
{
    data[i] = data[i - 4];
}
```

A.

1	2	3	4	5	1	2	3	4	5

B.

1	2	3	4	1	2	3	4	1	2

C.

1	2	3	1	2	3	1	2	3	1

D.

1	2	3	4	5	5	4	3	2	1

E.

5	4	3	2	1	1	2	3	4	5

Answer Sheet

1.	A	B	C	D	E
2.	A	B	C	D	E
3.	A	B	C	D	E
4.	A	B	C	D	E
5.	A	B	C	D	E
6.	A	B	C	D	E
7.	A	B	C	D	E
8.	A	B	C	D	E
9.	A	B	C	D	E
10.	A	B	C	D	E
11.	A	B	C	D	E
12.	A	B	C	D	E
13.	A	B	C	D	E
14.	A	B	C	D	E
15.	A	B	C	D	E

16.	A	B	C	D	E
17.	A	B	C	D	E
18.	A	B	C	D	E
19.	A	B	C	D	E
20.	A	B	C	D	E
21.	A	B	C	D	E
22.	A	B	C	D	E
23.	A	B	C	D	E
24.	A	B	C	D	E
25.	A	B	C	D	E
26.	A	B	C	D	E
27.	A	B	C	D	E
28.	A	B	C	D	E
29.	A	B	C	D	E
30.	A	B	C	D	E

Participant _____