19th International Microelectronics Olympiad

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.

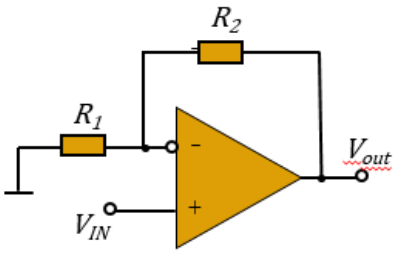
8.	A	B	C	D	E

Student _____

University _____

1. What will the connection of the capacitor in parallel with the negative feedback R_2 resistor in the circuit of the non-inverting amplifier lead to?

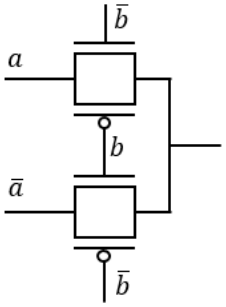
A. Amplification of low frequencies (low boost)
B. Amplification of high frequencies (high boost)
C. Attenuation of high frequencies (low pass)
D. Attenuation of low frequencies (high pass)
E. Amplitude-frequency characteristics will shift to the left



2. How will the connection of R_L load resistance at the output of the circuit affect charge and discharge processes of the integrating circuit capacitor?

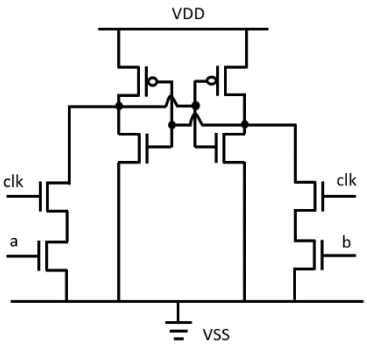
A. Will slow down the charging of the capacitor
B. Will accelerate the discharge of the capacitor
C. Will reduce the amplitude of output pulses
D. Will limit the output pulses to a certain level
E. All the answers are correct

3. What logic function is implemented in the figure?



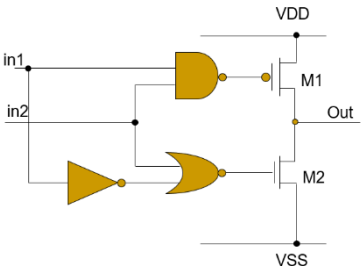
A. OR
B. XOR
C. XNOR
D. MUX
E. AND

4. What circuit is implemented in the figure?



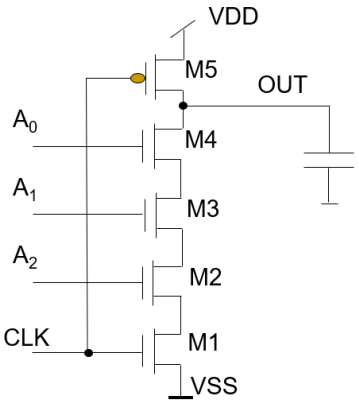
A. D latch
B. SR latch
C. JK flip-flop
D. T flip-flop
E. D flip-flop

5. The circuit is



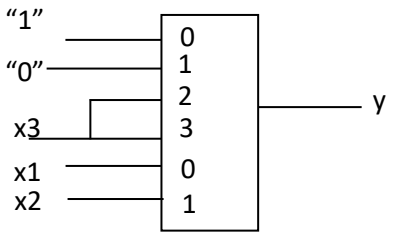
A. Tri-stage buffer
B. Tri-stage inverter
C. Multiplexer
D. XNOR
E. XOR

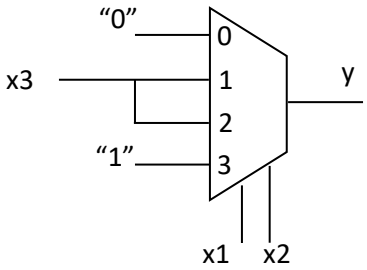
6. What are the necessary conditions for this circuit to be able to operate as a 3 input NAND?



A. CLK=0
B. CLK=1
C. CLK=0 and output capacitance is fully discharged
D. CLK=1 and output capacitance is fully charged
E. CLK=1 and output capacitance is fully discharged

7. Which of the following functions is implemented by the multiplexer circuit?





A. y=~x1~x2 +~x1x3
B. y=~x1~x2 +x3
C. y=~x1x2 +x3
D. y=x1~x2 +x3
E. There is no correct answer

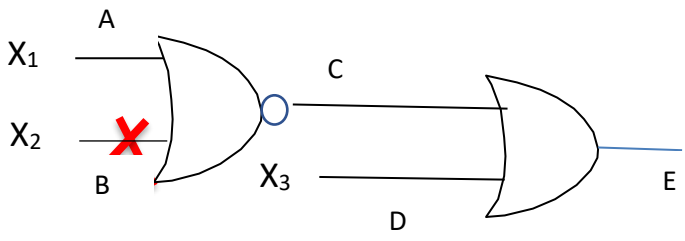
8. Determine the value of the following number , represented in single precision format (IEEE 704).

S	E (8 bits)	F (23 bits)
1	10000011	110000 . . . .

A. 30
B. -12
C. -28
D. 20
E. There is no correct answer

9. Among the algorithm complexities listed below, point out the ones which are applicable for testing large SRAM memories with n-bit words when n may be sufficiently large.
A. Algorithms of complexity O(n)
B. Algorithms of complexity O(nlogn)
C. Algorithms of complexity O($n^{3/2}$)
D. Algorithms of complexity O(n^2)
E. Algorithms of complexity O(n^3)

10. In the combinational circuit below, find all the test patterns that detect the stuck-at-0 fault on the line B marked in red color by using the method of "Truth tables". Among the listed five variants choose the correct one.
A. There are no solutions
B. All the input patterns detect the marked fault
C. (X_1,X_2,X_3)=(110) is the only pattern detecting the fault
D. (110) and (101) are test patterns detecting the fault
E. (010) is the only test pattern detecting the fault



$f(x_1, x_2, x_3)=(x_1+x_2)'+x_3$

X_1	X_2	X_3
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

11. What is the differences of Schottky diode from the traditional p-n junction diode?

A. It is based on metal-semiconductor junction
B. Lower voltage drop in case of forward -biased
C. Higher operating frequency
D. Higher switching speed
E. All the answers are correct

12. The width of the depletion region of reverse-biased p-n junction diode:

A. Decreases
B. Increases
C. First increases, then decreases
D. First decreases, then increases
E. Does not depend on the magnitude of the voltage

13. We have the condition: $f^2(x) = \int_0^x \left(f^2(t) + \left(f'(t)\right)^2\right) dt + 2024^2$ for differentiable function f. If we have $f(3) > 0$, find $\dfrac{\ln 2025}{\ln 2024}$.

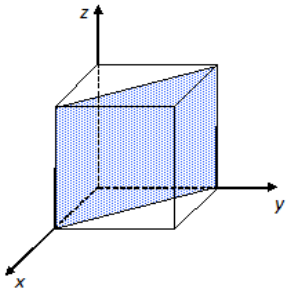
A. 1
B. e
C. π
D. 2023
E. In 2 2020

14. We have $A = \lim_{n\to\infty} \prod_{k=2}^{n} \left(1 - \frac{1}{k^2}\right) = \lim_{n\to\infty} \left(1 - \frac{1}{2^2}\right)\left(1 - \frac{1}{3^2}\right) \cdots \left(1 - \frac{1}{n^2}\right)$. Find $8A$.

A. 0
B. 2
C. 4
D. 6
E. 8

15. Which crystallographic plane is highlighted in the cubic lattice of a single crystal of silicon?

A. (100)
B. (101)
C. (111)
D. (110)
E. (011)



16. What is the technological method used to prepare A_3B_5 (GaAs, InP, InAs, GaSb) type semiconductor structures?

A. Diffusion
B. Heteroepitaxial growth
C. Homoepitaxial growth
D. Ion implantation method
E. None of the above

17. Which parameters of a semiconductor solar cell depend on the value of illuminated surface area?

A. Operating voltage
B. Operating current
C. Efficiency coefficient
D. Duty cycle
E. None of the above

18. Which of the following statements about the adjacency matrix for a graph containing m vertices and n edges is true?

A. Is an m x n order matrix whose diagonal elements are equal to 0
B. Is a square matrix of order m
C. Is a square matrix of order n
D. Is a symmetric matrix of order n
E. Is an m x n order matrix with diagonal elements equal to 1

19. Which of the given answers is correct? Along with the development of microelectronic technology,

A. Delay in interconnects increases
B. Specific resistance of interconnects decreases
C. Permissible temperature of p-n junction decreases
D. Proportion of static power in the total power consumption decreases
E. Thermal gradient across the area of the die decreases

20. Short and long waves of equal intensity are absorbed from the surface inwards. What intensity will be greater at depth x?

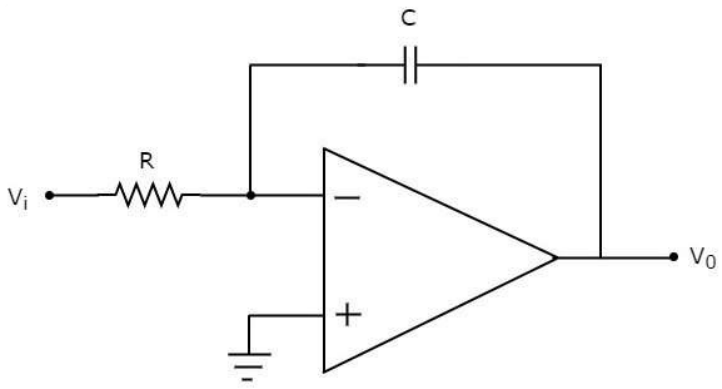
A. It will be the same
B. Shortwave
C. Long wave
D. The waves will be reflected
E. The waves will be deflected

21. What happens to the current of a forward biased diode if the voltage is not enough to overcome the potential barrier?

A. Will grow
B. Will decrease
C. Will remain the same
D. Will stop
E. Will remain small

22. Which is the main function of provided circuit in the figure?

A. Comparator
B. Differentiator
C. Integrator
D. Generator
E. Data converter



23. What is mobility dependence from temperature (consider room temperatures) in a MOS transistor?

A. Mobility remains constant
B. Mobility decreases as temperature increases
C. Mobility increases as temperature increases
D. Depends on transistor type
E. There is no direct relationship

24. What will be the output of the following code?

```
#include<stdio.h>

int main()

{

   int arr[] = {10, 20, 30, 40, 50, 60};

   int *p = arr;

   *(p++)+=123;

   printf("%d , %d", *p, *(++p));

   return 0;

}
```

A. *20 , 30*
B. *133 , 30*
C. *133 , 40*
D. *133 , 20*
E. *143, 30*

25. What is the time complexity of the following code?

```
int computeHalf (int number) {
   if (number < 1) {
      return number;
   } else {
      return computeHalf(number / 2) + 1;
   }
}
```

A. *O(nlogn)*
B. *O(logn)*
C. *O(2^n)*
D. *O(n^2)*
E. *O(n)*

26. What will be the output of the following code?

```
#include <iostream>

int main() {
   int* ptr = new int(10);
   *ptr++;
   std::cout << *ptr << std::endl;
   delete ptr;
   return 0;
}
```

A. *Compile Error*
B. *11*
C. *Undefined*
D. *10*
E. *12*

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

Student _____

University _____