C-8

ENTRANCE EXAMINATION 2023

Ph.D. (Electronics Science and Engineering)

Marks: 70

Time 2.00 hrs   Hall Ticket no.

Write your Hall ticket number in the OMR Answer Sheet given to you and the space provided above.

Read the following instructions carefully before answering the questions

1.   This question paper has two parts "PART A" and "PART B"
2.   PART A consists of 20 objective type questions of 1.75 marks each. There is no negative marking
3.   PART B consists of 20 objective type questions of 1.75 marks each. There is no negative marking
4.   All questions are to be answered. Answers for these questions are to be entered in the OMR sheet by filling the appropriate circle against each question. For example if the answer to a question is D it should be marked as below

$$\text{(A)} \quad \text{(B)} \quad \text{(C)} \quad \bullet$$

5.   No additional sheets will be provided. Rough work can be done on the question paper itself.
6.   Handover the OMR sheet to the invigilator at the end of the examination
7.   Mobile phones, log tables and calculators of any kind are NOT permitted
8.   Values of some physical constants: Planck's constant = 6.6×10^{-34} m^2kg/s ; speed of light in vacuum = 3×10^8 m/s; Boltzmann constant = 1.38×10^{-23} m^2kgs^{-2}K^{-1}; free space permittivity = 8.85×10^{-12} F/m; electronic charge = 1.6×10^{-19} C, mass of electron = 9.1×10^{-31} kg, Thermal voltage = 0.026 V
9.   This question paper contains 09 pages including this cover sheet.

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PART A

1. The Maclaurin series for sin^2x is

A. $x^2 - \frac{x^4}{3} + \frac{2x^6}{45}$

B. $x^2 + \frac{x^4}{3} + \frac{2x^6}{45}$

C. $x^2 - \frac{x^2}{3} + \frac{x^3}{9}$

D. $-x^2 + \frac{x^4}{3} - \frac{2x^6}{45}$

2. The half digits and range that a 3 ¾ digital voltmeter can display are, respectively

A. 0,1,2, and -3999 to +3999
B. 0, 1, 2, 3 and -3999 to +3999
C. 0,1,2,3 and -1999 to +1999
D. 0,1 and -3999 to +3999

3. Read the passage and answer the question below

> To help prevent unauthorized email, UoH assigns a random email address to your printer. It never publicize this address and by default it does not respond to any sender. UoH also provides industry standard spam filtering and transforms email and attachments to a print only format to reduce the threat of a virus or other harmful content.

> From the above it can be inferred that UoH

A. is a printer that protects from virus attacks
B. is a spam filter provider
C. assigns a random email address to the printer and does not respond to emails
D. transforms emails into virus.

4. Read the passage and answer the question below

> In modern networks, data are transferred using packet switching. Messages are broken into units called packets and sent from one device to another. At the destination device, data are extracted from one or more packets and used to reconstruct the message. Each packet has a maximum size and consists of a header and data/ payload area. The packet size is around 1.5 kilobytes for Ethernet and 64 kilobytes for IP payloads. The header contains the addresses of the source and destination devices as well as sequencing information required to reconstruct the message

> From the above passage it can be inferred that data transfer across a network

A. takes place using electronic switches
B. is also called Ethernet
C. is extracted from packets called a header and a device called payload
D. is broken into packets which are of 64 kilobyte size for IP payloads

5. Consider the equation below (a and K are constants)

$$y = \sqrt{\frac{x^3}{a} + K^2}$$

Which of the following statements is correct?

A. The slope of a graph between y^2 and x^3 is K^2 and the y–intercept is $1/a$
B. The slope of a graph between y^2 and x^3 is $1/a$ and the y–intercept is K^2
C. The slope of a graph between y and x is $1/a$ and the y–intercept is K^2
D. The slope of a graph between y and x is K^2 and the y–intercept is $1/a$

6. It can be inferred, based on the data given in the table below that

x	y_1	y_2
-3	20.09	8
-2	7.389	4
-1	2.718	2
0	1	1
1	0.3679	1/2
2	0.1353	1/4
3	0.0498	1/8

A. $y_1 = 1/e^x$ and $y_2 = 2^x$
B. $y_1 = e^x$ and $y_2 = 2^x$
C. $y_1 = 1/e^x$ and $y_2 = (1/2)^x$
D. $y_1 = e^x$ and $y_2 = (1/2)^x$

7. If it is required to fit square dies of side 'l' on a circular wafer of diameter 'D', then the total of square dies, 'N', that can be fit on this wafer (assuming $l \ll D$) is proportional to

A. D^2/l
B. l^2/D^2
C. l^2
D. D^2/l^2

8. Identify the correct statement or statements

I. Soft IPs in VHDL/Verilog code provide functional description of IPs; II. Soft IPs are hard layouts using physical design libraries; III. Soft IPs are technology dependent and lack flexibility

A. I only
B. I and II
C. I only
D. I, II and III

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9. The mean and variance of a random variable which follows the binomial distribution after a certain number of trials are 4 and 2.4, respectively. The number of trials is

A. 20
B. 15
C. 10
D. 18

10. The number of significant digits in the result of multiplication of 2.3 and 3.243 will be

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

11. Which of the following are valid Boolean expressions?

I. $A + AB = B$
II. $A + \overline{AB} = 1$
III. $A + A\bar{B} = A + \bar{B}$
IV. $A + \bar{A}B = A + B$

A. I, IV
B. II, IV
C. I, II, IV
D. II, III

12. The full scale voltage and accuracy of an ADC are 5 V and 25 mV respectively. The optimal number of bits for this ADC to give best possible resolution are

A. 4- bit
B. 7-bit
C. 8-bit
D. 12-bit

13. Highest frequency band allocated for 5G operation in India is:

A. 3.3 – 3.8 GHz
B. 3.3 – 4.2 GHz
C. 20.25 – 21.5 GHz
D. 24.25-27.5 GHz

14. Consider three numbers $x = 4^{40}$, $y = 2^{80}$ and $z = 3^{80}$. Which of the following statements is correct?

A. $x = y < z$
B. $x = y > z$
C. $x > y < z$
D. $x > y > z$

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15. The dynamic power dissipation of a CMOS inverter

    A. increases linearly with biasing voltage and quadratically with clock frequency
    B. increases linearly with clock frequency and quadratically with biasing voltage
    C. decreases linearly with biasing voltage and increases quadratically with clock frequency
    D. increases linearly with biasing voltage and is independent of clock frequency

16. If the outcome or result of a researcher's experiment is not consistent with the theory it is expected to confirm then the appropriate action for the researcher is to

    A. discard the experiment and work on a new problem.
    B. submit the results immediately for publication.
    C. repeat the experiment a large number of times to validate the results.
    D. force-fit the outcome to be consistent with the theory.

17. In a class, 40% of the students are offered Digital IC design, 50% of the students are offered VLSI fabrication and 10% of the students are offered both courses. If a student is selected randomly from the class, the probability that she or he is offered Digital IC design is

    A. 2/3
    B. 1/6
    C. 3/5
    D. 4/5

18. An equivalent circuit model that is used for a small AC signal applied across a forward biased diode is

    A. a resistance.
    B. a resistance and capacitance in parallel.
    C. a resistance and capacitance in series.
    D. capacitance.

19. The inverse Fourier transform of

$$\frac{1}{8 + 3j\omega}$$

    is

    A. $e^{+\frac{8t}{3}}$
    B. $e^{-\frac{8t}{3}}$
    C. $\frac{1}{3} e^{-\frac{8t}{3}}$
    D. $\frac{1}{3} e^{-8t}$

20. If $f(x) = x^3 - x^2 + x - 1 = 0$, considering the initial approximation at $x = 3$, the value of first approximation correct up to one decimal place is

    A. 2.1
    B. 3.9
    C. 4.1
    D. 1.9

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PART B

21. A keyboard has 5 keys and it generates an equivalent 3-bit number ($D_2D_1D_0$) that is fed to a decoding circuit shown in the figure.
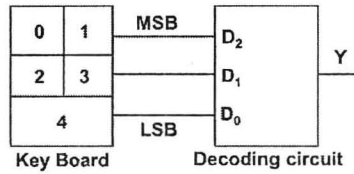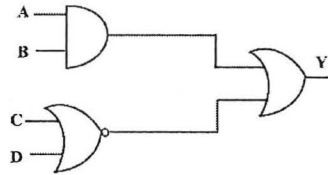

If the output of this decoding circuit (Y) is logic "HIGH" when the key "1" is pressed, then the simplest expression for Y is

A. $Y = D_1D_0$
B. $Y = \overline{D_1}\, D_0$
C. $Y = D_2D_1\overline{D_0}$
D. $Y = \overline{D_2}\,\overline{D_1}\, D_0$

22. The dual expression for the output (Y) of the circuit shown is

A. $(A + B)(\bar{C} + \bar{D})$
B. $(\bar{A} + \bar{B})(C + D)$
C. $(\overline{AB})(\overline{CD})$
D. $A\bar{C} + B\bar{C} + A\bar{D} + B\bar{D}$

23. In a circuit, the inverting input of a differential amplifier is grounded. The purpose of the grounding is to

A. convert the differential amplifier to a normal amplifier.
B. increase the input impedance.
C. cancel noise.
D. increase the bandwidth.

24. A plane wave travelling in free space is incident normally on to a medium with a dielectric constant of 4, the fraction of incident power entering into the second medium is approximately equal to

A. 0.1
B. 0.25
C. 0.33
D. 0.9

25. A transmission line is short circuited at a length of $\lambda/3$. The characteristic impedance of the line is 50Ω. Then its input impedance is:

A. $-j\,100\,\Omega$
B. $-j\,86.6\,\Omega$
C. $86.6\,\Omega$
D. $50\,\Omega$

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26. For a two wire transmission line embedded in a plastic with a dielectric constant of 9, two adjacent voltage maxima are at distances of 15 *cm* and 18 *cm* from the source. The operating frequency of the line is?

    A. 5 GHz
    B. 3.33 GHz
    C. 1.67 GHz
    D. 10 GHz

27. If the doping concentration of a *p*-type Si sample is increased by five orders of magnitude, then its surface potential will

    A. Increase by a factor of 5
    B. Decrease by a factor 5
    C. Increase by 5 orders of magnitude
    D. Decrease by a factor of *ln*(5)

28. A series has a step response given by

$$S(t) = 2\left(1 - e^{-\frac{t}{5}}\right)u(t)$$

The minimal sampling interval such that every sample has settled to at least 98% of true value is

    A. 5 s
    B. 10 s
    C. 5 *ln*10 s
    D. 10 *ln*5 s

29. Two MOS transistors (Q_1 and Q_2) are used to charge two capacitors (C_1 and C_2) as shown in the figure. The magnitude of the threshold voltage ($|V_T|$) of these two transistors is 0.4 V. If the capacitors are charged to the maximum possible values, then the gate to source voltages (V_{GS}) of these transistors are

    A. $V_{GS}(Q_1) = 2$ V and $V_{GS}(Q_2) = 0$ V
    B. $V_{GS}(Q_1) = 0.4$ V and $V_{GS}(Q_2) = -5$ V
    C. $V_{GS}(Q_1) = 0.4$ V and $V_{GS}(Q_2) = -0.4$ V
   D. $V_{GS}(Q_1) = 1.6$ V and $V_{GS}(Q_2) = -5$ V
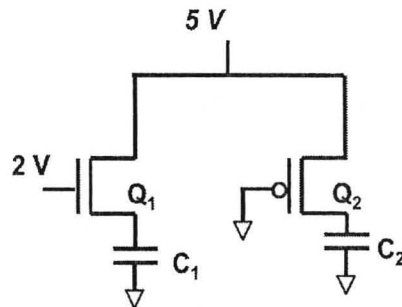
30. The Fan-out of a driving gate can be enhanced by

    A. Minimizing input current of the drive gate
    B. Minimizing the output resistance of the load gates
    C. Minimizing the input currents of the load gates
    D. Increasing the input resistance of the drive gate

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31. In the given circuit, $V_{DD}=3V$, $V_{in}=1V$, $V_{thn}=0.6V$, $|V_{thp}|=0.7V$. If M1 is operating in saturation region, then the small signal voltage gain is approximately
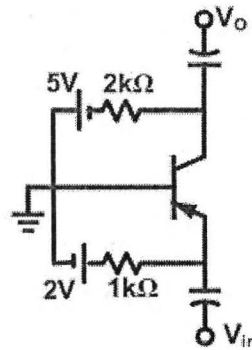
   A. 5
   B. 3
   C. 6
   D. 10
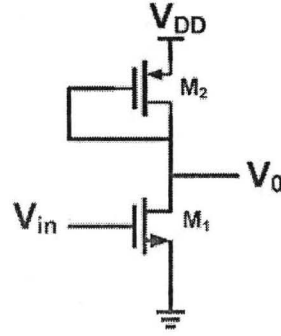
32. The output voltage for the given operational amplifier circuit is
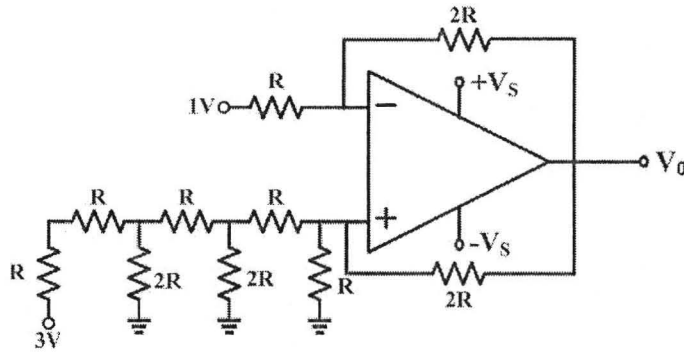
   A. 1 V
   B. 2 V
   C. -1 V
   D. -2 V

33. For the given circuit of Bipolar Junction Transistor, Base to emitter voltage (V_{BE}) is - 0.7 V and Collector to Base current gain is given as 50. The collector to base voltage V_{CB} and Base Current I_{B}, are respectively

   A. 2.4 V, 65 µA
   B. -3 V, 26 µA
   C. 3 V, 65 µA
   D. -2.4 V, 26 µA

34. A short channel MOSFET has channel length L, the junction depth of the source to substrate region is x_{js} and drain to substrate region is x_{jd}. The condition at which punch-through takes place is

   A. $L > x_{js} + x_{jd}$
   B. $L \leq x_{js} + x_{jd}$
   C. $L > x_{js} - x_{jd}$
   D. $L = x_{jd} - x_{js}$

35. An intrinsic sample of *Si* is doped with an impurity such that it creates electron energy levels at 0.001 eV below the conduction band. The dopant is likely to be a

   A. pentavalent element such as *Sb* that transforms intrinsic *Si* into an *n*-type semiconductor
   B. pentavalent element such as *P* that transforms intrinsic *Si* into a *p*-type semiconductor
   C. trivalent element such as *Al* that transforms intrinsic *Si* into a *n*-type semiconductor
   D. trivalent element such as *As* that transforms intrinsic *Si* into a *p*-type semiconductor

36. In the fabrication of a semiconductor device, a method of patterning a target material (typically a metal) using a sacrificial layer (typically photoresist) to define the pattern is called

   A. etching
   B. lift-off
   C. deposition
   D. epitaxy

37. The preferred method to form SiO_2 as a gate dielectric on a *Si* wafer is

   A. magnetron sputtering
   B. thermal evaporation
   C. thermal oxidation
   D. molecular beam epitaxy

38. Which of the following statements is false?

   A. Gauss elimination method is used for solving system of linear equations
   B. Simplex method is used for solving linear programming models
   C. Runge Kutta method is used to solve differential equations
   D. Trapezoidal method is used to approximate indefinite integrals

39. A 3-bit asynchronous binary counter has 3 negative edge triggered D flip flops and each flip flop has a propagation delay of 15 *ns*. The highest frequency allowed to the counter for safe operation is

   A. 6.6 MHz
   B. 6.6 kHz
   C. 15 GHz
   D. 15 MHz

40. If n, p and n_i are the electron, hole and intrinsic carrier concentrations of a semiconductor respectively, then which of the following conditions leads to thermal generation?

   A. $n < p$
   B. $np = n_i^2$
   C. $np > n_i^2$
   D. $np < n_i^2$

Key PhD (Electronics Sciences and Engineering) 2023

1	A	21	B
2	B	22	A
3	C	23	C
4	D	24	D
5	B	25	B
6	C	26	C
7	D	27	A
8	A	28	D
9	C	29	B
10	D	30	C
11	B	31	A
12	C	32	C
13	D	33	D
14	A	34	B
15	B	35	A
16	C	36	B
17	D	37	C
18	A	38	D
19	C	39	A
20	A	40	D

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