



భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Advt. No. IITH/2023/NF/15

Post Code: 12.6

Question Paper Code: 117

Application Number of the Candidate

Name of the Post: JTS Electrical Engg. (Micro & VLSI)

Pay Level:

Date & Time of the Exam: Mon, 18-Dec-2023, 10 AM - 12 PM

Duration: 2 hr

Scheme of the Exam:

Topic	Number of Question	Marks
Work Related Topics	70	70
General Arithmetic	10	10
Reasoning	10	10
General English (Communication Skills)	10	10

Instructions to fill the responses in the OMR answer sheet:

1. Candidate must write his/her **application number** in the designated box on the top of OMR answer sheet.
2. Candidates must write the post code and Question paper code in the designated boxes on the top of OMR answer sheet.
3. Candidates must sign in the box provided in the OMR answer sheet.
4. Each answer sheet must be signed by the invigilator in the space printed in the OMR answer sheet.
5. Only one response to be selected & marked. In case more than one response is marked for a single question or no response is marked for a question, no marks will be awarded for that question.
6. Partially filled circles shall not be considered as responses.
7. Erasing or changing of answer is not allowed.
8. No negative marking
9. Candidate must use Blue/Black ball point pen to fill his/her responses.
10. Rough work should not be done on the OMR answer sheet.
11. Candidates can use the designated page(s) of the question booklet for the purpose of rough work.

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1 Electronic Devices and Circuits

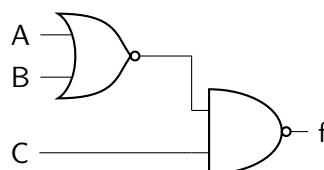
20 marks

1. An ideal diode has _____ and _____
 - A. some forward voltage drop, some reverse recovery time
 - B. high switching losses, high reverse voltage drop
 - C. no forward voltage drop, negligible reverse recovery time
 - D. no reverse recovery time, high leakage current
2. The resonant frequency of a parallel LC circuit (τ) is given by
 - A. $1/(2\pi\sqrt{LC})$
 - B. $2\pi\sqrt{LC}$
 - C. $1/(2\sqrt{LC})$
 - D. \sqrt{LC}
3. Kirchhoff's laws are valid for
 - A. Linear circuits only
 - B. Passive time invariant circuits
 - C. Nonlinear circuits only
 - D. Both the linear and nonlinear circuits
4. Which of the following statements is correct?
 - A. Resistance is a passive element
 - B. MOSFET is an active element
 - C. Diode is a non-linear device
 - D. A, B, and C are correct
5. The resistance of a copper wire _____ with the increase in temperature
 - A. Decreases
 - B. Remains constant
 - C. Increases
 - D. First increases and then decreases
6. Addition of trivalent impurity to a semiconductor creates many _____
 - A. Holes
 - B. Free electrons
 - C. Valence electrons
 - D. Bound electrons
7. In the depletion region of a pn junction, there is a shortage of _____
 - A. Acceptor ions
 - B. Holes and electrons
 - C. Donor ions

- D. None of the above
8. At absolute zero temperature, an intrinsic semiconductor has _____
- A. A few free electrons
 - B. Many holes
 - C. Many free electrons
 - D. No holes or free electrons
9. A current ratio of I_C/I_E is usually less than one and is called:
- A. Beta
 - B. Theta
 - C. Alpha
 - D. Omega
10. Amplifiers and oscillators using BJT, operate in _____ region
- A. Inverted mode
 - B. Active
 - C. Cut off
 - D. Saturation
11. In applications where _____ input resistance is needed, the JFET is preferred to the bipolar transistor
- A. Low
 - B. Very low
 - C. Zero
 - D. High
12. The operation of a JFET involves
- A. A flow of minority carriers
 - B. Negative resistance
 - C. Recombination
 - D. A flow of majority carriers
13. Transistor works as an open switch when emitter junction is _____ biased and collector junction is _____ biased
- A. Forward, forward
 - B. Reverse, reverse
 - C. Reverse, forward
 - D. Forward, reverse
14. Choose the correct statement
- A. MOSFET is a voltage controlled device
 - B. MOSFET is a uncontrolled device

- C. MOSFET is a current controlled device
 D. MOSFET is a temperature controlled device
15. The output characteristics of a MOSFET, is a plot of
- I_d as a function of V_{gs} with V_{ds} as a parameter
 - I_g as a function of V_{gs} with V_{ds} as a parameter
 - I_d as a function of V_{ds} with V_{gs} as a parameter
 - I_g as a function of V_{ds} with V_{gs} as a parameter
16. Assume that the Fermi level in a semiconductor is near the valence band. Which of the following is true?
- $n = p = n_i$
 - $n > p, n \gg n_i$
 - $n < p, n \gg n_i$
 - $p \gg n, n \ll n_i$
17. Consider a PN junction with a built-in potential V_0 and an applied bias of V_A . The ratio of excess hole concentration at the edge of the depletion region relative to the equilibrium hole concentration in the n side is given by
- $\exp(q(V_A - V_0))$
 - $p_{n0}\exp(q(V_0 - V_A))$
 - $n_{p0}\exp(q(V_A - V_0))$
 - $\exp(q(V_0 - V_A))$
18. As temperature increases from 0 K to high temperature, the carrier concentration in a semiconductor goes through three regions. In what order does the transition occur?
- intrinsic, extrinsic, freezeout
 - extrinsic, intrinsic, freezeout
 - freezeout, intrinsic, extrinsic
 - freezeout, extrinsic, intrinsic
19. The drain current of an ideal MOSFET follows the equation $I_D = \kappa[(V_{GS} - V_T)V_{DS} - 1/2V_{DS}^2]$. If the MOSFET is designed such that $\kappa = 1 \text{ mA/V}^2$, what is the drain current for $V_{GS} - V_T = 0.5 \text{ V}$ and $V_{DS} = 1 \text{ V}$?
- 0 mA
 - 1 mA
 - 0.25 mA
 - 0.125 mA

20. Find and simplify the output f of the circuit below:

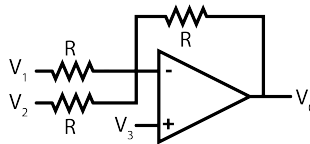


- A. $f = \overline{(\overline{AB}) \cdot C}C$
- B. $f = A + B + \overline{C}$
- C. $f = \overline{(A + B) \cdot \overline{C}}$
- D. $f = \overline{ABC}$

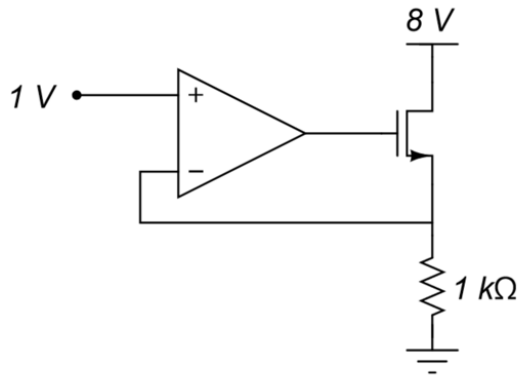
2 Laboratory Instruments and Measurements

10 marks

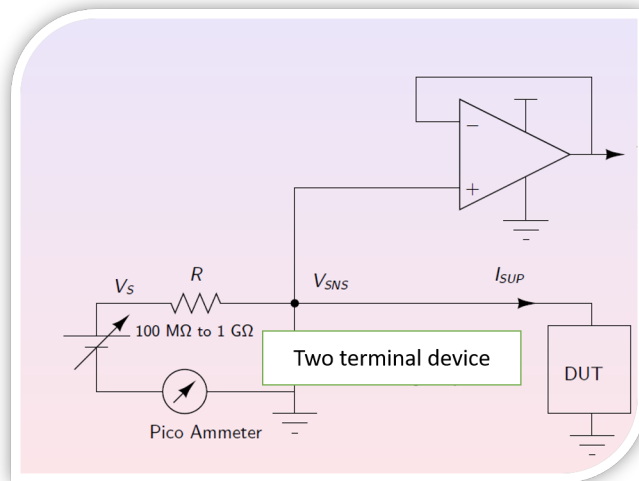
21. A 1 KHz square wave ($t_r = t_f = 1 \mu s$) is fed into an ideal low pass filter ($f_0 = 1.5 KHz$). The output of the filter will be
- A. 1 KHz sine wave
 - B. 1 KHz square wave similar to input
 - C. 1 KHz square wave with $t_r = t_f > 1 \mu s$
 - D. 1 KHz square wave with $t_r = t_f < 1 \mu s$
22. The output voltage V_O for an ideal Opamp circuit shown in figure below is given by



- A. $-V_1 - V_2 + V_3$
 - B. $-V_1 - V_2 + 3V_3$
 - C. $-V_1 + V_2 - 3V_3$
 - D. $V_1 + V_2 + 3V_3$
23. Current can be converted to voltage _____
- A. through a voltmeter
 - B. through a resistance
 - C. through an ammeter
 - D. through a galvanometer
24. Quantities are digitised using _____
- A. D/A converter
 - B. oscillator
 - C. amplifier
 - D. A/D converter
25. Basic building blocks of digital multimeter are _____
- A. oscillator, amplifier
 - B. diode, op amp
 - C. rectifier, schmitt trigger
 - D. A/D, attenuator and counter



26. For the circuit shown in below figure, how many probes are needed to find the gate to source voltage of the MOSFET
 A. 1 B. 2 C. 3 D. 4
27. The circuit shown in the below figure is used to measure the ultra low current drawn by the design under test. It was observed that there was huge ripple on V_{SNS} . To reduce the ripple on V_{SNS} , which two terminal device is necessary



- A. Resistor
 B. capacitor
 C. Inductor
 D. Diode
28. Example of intrinsic noise in circuits is _____
 A. Noise generated by op amps
 B. 50 Hz line pickup

- C. Noise induced due to radiation
 - D. All of the above
29. The $1/f$ noise region is dominant at _____
- A. High frequencies
 - B. Low frequencies
 - C. Intermediate frequencies
 - D. All frequencies
30. How do you find the total noise for two series noise sources (V_{n1} , and V_{n2})?
- A. Add them ($V_{n1} + V_{n2}$)
 - B. Multiply the voltages of the two sources
 - C. Average the two sources
 - D. Calculate *rms* value ($\sqrt{\langle V_{n1} \rangle^2 + \langle V_{n2} \rangle^2}$)

3 PCB Design and Testing

10 marks

31. What is the typical dielectric constant of FR4 material?
- A. Around 2
 - B. Around 3
 - C. Around 4
 - D. Around 5
32. Thickness of 10 mils is almost equal to
- A. $2.5 \mu\text{m}$
 - B. $25 \mu\text{m}$
 - C. $250 \mu\text{m}$
 - D. $2500 \mu\text{m}$
33. What is the characteristics impedance of a microstrip line on PCB?
- A. Sheet resistance of the signal plane conductor
 - B. Sheet resistance of the ground plane conductor
 - C. Sum of the sheet resistances of signal and ground planes conductor
 - D. None of the above
34. Thickness of copper layer in a PCB is typically mentioned in oz. (ounce per sq. feet). 1 oz. is equal to
- A. $35 \mu\text{m}$
 - B. $70 \mu\text{m}$
 - C. $100 \mu\text{m}$
 - D. $150 \mu\text{m}$
35. How many conductors are present in a regular coaxial cable?

- A. 1
- B. 2
- C. 3
- D. 1

36. Choose the option showing correct trend for maximum frequency of operation for various coaxial cables

- A. SMA > 3.5 mm > BNC
- B. 3.5 mm > SMA > BNC
- C. BNC > 3.5 mm > SMA
- D. 3.5 mm > BNC > SMA

37. Choose mechanically compatible connectors pair

- A. BNC and N-type
- B. BNC and SMA
- C. 3.5 mm and 2.92 mm
- D. N-type and SMA

38. Choose the option which correctly describes an impedance controlled board

- A. A controlled impedance is added in signal plane
- B. A controlled impedance is added in ground plane
- C. Characteristics impedance of signal trace is controlled
- D. A controlled impedance is added in signal as well as ground plane

39. What is the dielectric material used in a SMA connector?

- A. Air
- B. FR4
- C. PTFE
- D. Ceramic

40. A $50\ \Omega$ SMA cable has a total capacitance of 2 F. What is its delay?

- A. 25 s
- B. 100 s
- C. 40 ms
- D. 10 ms

4 Miscellaneous Topics

30 marks

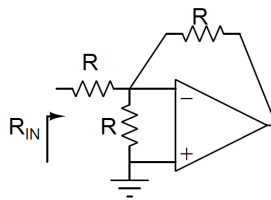
41. DC voltage of 54.6 V is applied across an electric bulb which draws 3.76 A current. What is the power consumed by the bulb with appropriate number of significant digits

- A. 205 W B. 205.3 W C. 205.30 W D. 205.296 W

42. 4 μA current flows through a conductor for 4s. Find the number of electrons passed through the conductor.
 A. $16e-6$ B. 16 C. $1e14$ D. $16e14$

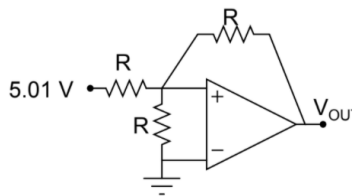
43. The logical expression $F = AC + B\bar{C}$ can be used to implement which of the following
 A. Decoder
 B. Multiplexer
 C. Encoder
 D. Adder

44. The input resistance of the circuit shown in the below figure is



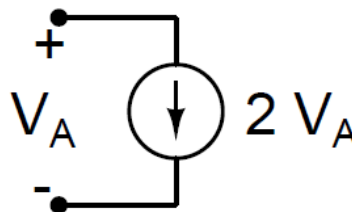
- A. R
- B. 3R
- C. 2R
- D. 1.5R

45. The circuit shown in the below figure has supply rails as $\pm 5\text{V}$. Approximate V_{OUT} can be found as

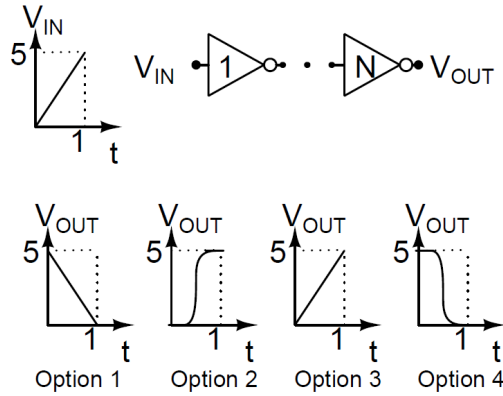


- A. -5 V
- B. 0 V
- C. 2.5 V
- D. 5 V

46. The circuit shown in the below figure, the resistance seen by the voltage source V_A



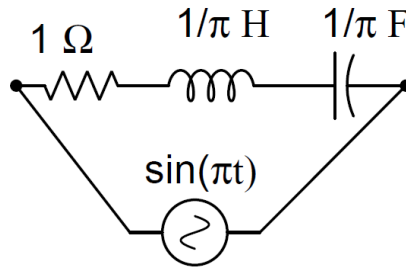
- A. $2\ \Omega$
- B. $0.5\ \Omega$
- C. $1\ \Omega$
- D. $\text{inf}\ \Omega$



Consider the figure above and answer the next two questions on inverter chain characteristics

47. The circuit shown above, which of the waveform is closer to the output when $N=1000$.
 A. Option 1 B. Option 2 C. Option 3 D. Option 4
48. The circuit shown above, which of the waveform is closer to the output when $N=1001$.
 A. Option 1 B. Option 2 C. Option 3 D. Option 4

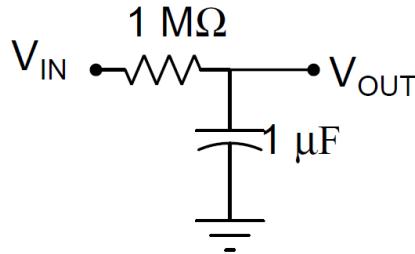
Consider the series resonant circuit below and answer the next six questions



49. The circuit shown in the above figure, resonance frequency is
 A. $1/2$ Hz B. $1/(2\pi)$ Hz C. $1/(4\pi)$ Hz D. 2 Hz
50. The circuit shown in the above figure, peak of the voltage across the inductor at resonance is
 A. 2 V B. 1 V C. $1/\pi$ V D. 0 V
51. The circuit shown in the above figure, sum of the voltage across the inductor and capacitor at resonance is
 A. 2 V B. 1 V C. $1/\pi$ V D. 0 V
52. The circuit shown in the above figure, impedance in Ω seen by the voltage source at resonance is
 A. 1 B. $1+j$ C. $1-j$ D. 0
53. The circuit shown in the above figure, impedance in Ω seen by the voltage source at DC is
 A. 1 B. ∞ C. $1+j$ D. 0

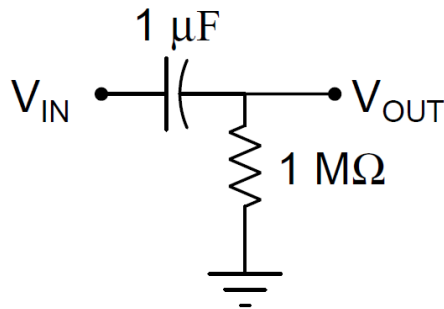
54. The circuit shown in the above figure, impedance in Ω seen by the voltage source at ∞ frequency is
 A. 1 B. 0 C. $1+j$ D. ∞

Consider the figure below and answer the next two questions

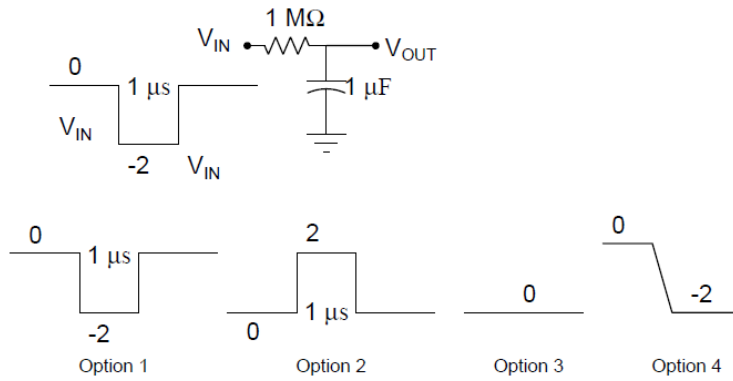


55. The circuit shown in the figure, the 3 dB bandwidth can be estimated as
 A. 1 rad/sec B. $1/(2\pi)$ rad/sec C. 2π rad/sec D. Not defined
56. For the circuit shown in the above figure, V_{OUT} when V_{IN} is $1+\sin(1G \times t)$
 A. 0 B. same as V_{IN} C. $\sin(1G \times t)$ D. 1V

Consider the figure below and answer the next two questions

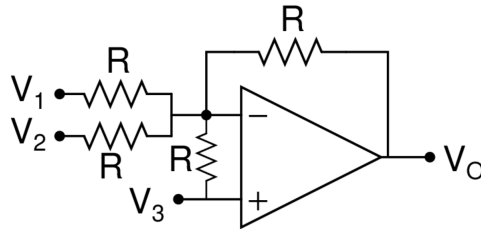


57. The circuit shown in the above figure, the time constant can be estimated as
 A. $1/(2\pi)$ sec B. 2π sec C. Not defined D. 1 sec
58. For the circuit shown in the above figure, V_{OUT} when V_{IN} is $1+\sin(1G \times t)$
 A. 0 B. same as V_{IN} C. $\sin(1G \times t)$ D. 1 V
59. For the circuit shown in the below figure, the V_{OUT} is close to
 A. Option 1 B. Option 2 C. Option 3 D. Option 4
60. The input and output resistance of the ideal trans-resistance amplifier respectively is
 A. 0 and ∞



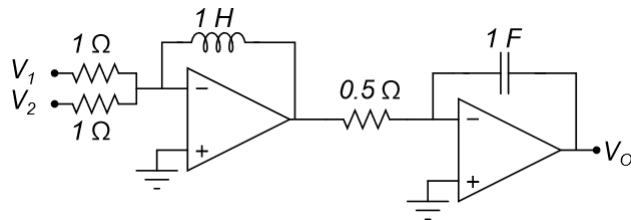
- B. ∞ and 0
- C. ∞ and ∞
- D. 0 and 0

61. For the circuit shown in the figure below, the output voltage, V_O can be expressed as



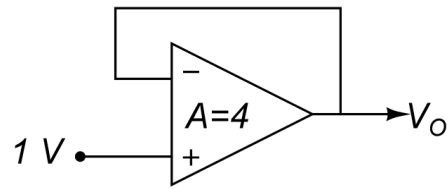
- A. $V_1 + V_2 + V_3$
- B. $V_1 + V_2 - V_3$
- C. $-V_1 - V_2 + 3V_3$
- D. $-V_1 - V_2 + 2V_3$

62. The circuit shown in the figure below, works as



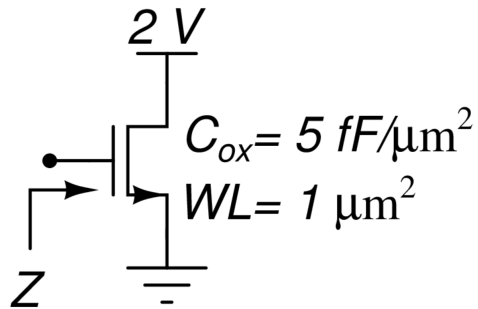
- A. Band pass filter
- B. High pass filter
- C. Band stop filter
- D. All pass filter

63. The circuit shown in the figure below has an amplifier gain, A of 4, then the output voltage, V_O is,



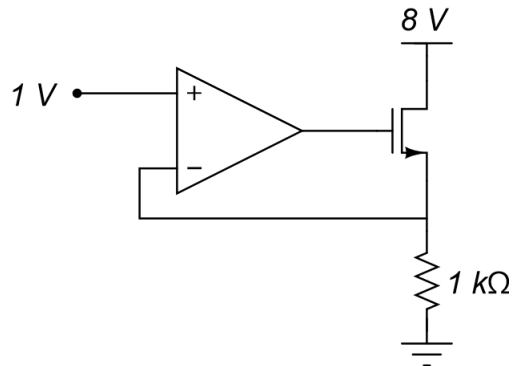
- A. $4/5$
- B. $5/6$
- C. 1
- D. 4

64. The input impedance at 1 MHz for the circuit shown in the figure below is,



- A. 0
- B. $33 \text{ M}\Omega$
- C. $66 \text{ M}\Omega$
- D. ∞

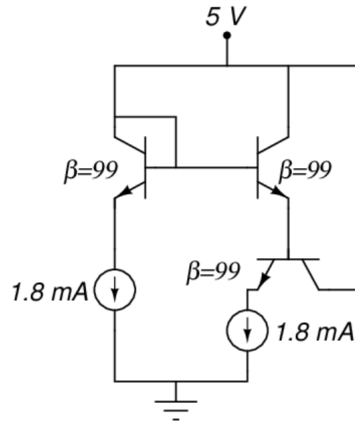
65. For the circuit shown in the below figure, the current through the MOSFET is



- A. 0.11 mA

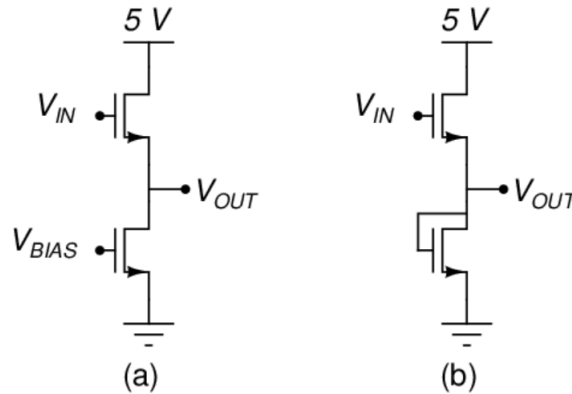
- B. 0.1 mA
- C. 1.1 mA
- D. 1 mA

66. For the circuit shown in the below figure, the total power drawn from the supply is,



- A. 18 mW
- B. 9 mW
- C. 4 mW
- D. 2 mW

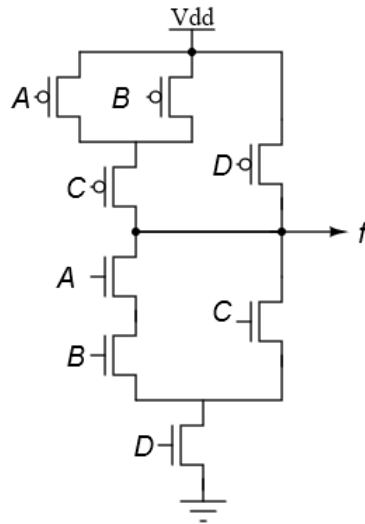
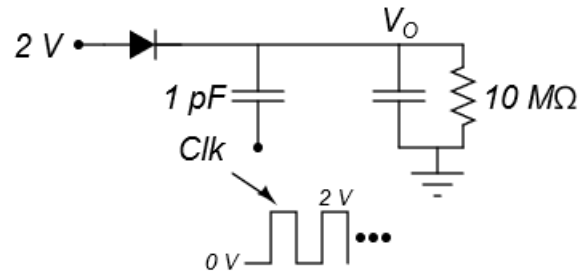
67. R_{O1} and R_{O2} are the output resistance of the circuits shown in the below figures (a) and (b) respectively. Following statements are true



- A. $R_{O1} < R_{O2}$
- B. $R_{O1} = R_{O2}$
- C. $R_{O1} > R_{O2}$
- D. $R_{O2} = 2R_{O1}$

68. For the circuit shown in the below figure, diode is ideal then the average value of the output voltage, v_O for the Clk frequency of 100 Hz and load capacitance of $1 \mu F$ is

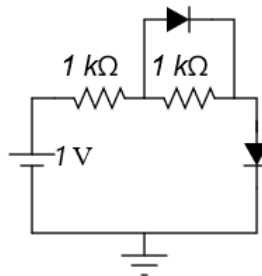
- A. 4
- B. 3.5
- C. 2
- D. 3



69. The boolean function for the circuit shown in the above figure is,

- A. $f = ((A + B)C + D)'$
- B. $f = (A + B)C + D$
- C. $f = ((AB + C)D)'$
- D. $f = (AB + C)D$

70. The diodes shown in below figure have cut-in voltage of 0.7 V. The approximate current drawn from 1 V supply is



- A. 0.5 mA
- B. 0 mA
- C. 0.3 mA
- D. 0.15 mA

5 General Arithmetic

10 marks

71. If the ratio of boys to girls in a class of students is known to be 7:6, then the total strength of the class could be:
- A. 64
 - B. 52
 - C. 49
 - D. 51
72. If θ denotes the angle between the longest diagonal of a cube and any one of its edges, then $\sin \theta$ is equal to
- A. $\frac{1}{\sqrt{3}}$
 - B. $\sqrt{\frac{2}{3}}$
 - C. $\frac{1}{\sqrt{2}}$
 - D. $\frac{1}{2\sqrt{3}}$
73. If a circle, square and an equilateral triangle are all constructed to have the same perimeter, then:
- A. Circle has the largest area
 - B. Circle has the smallest area
 - C. Triangle has the largest area
 - D. All have the same area
74. If a, b, c are integers such that $\log|a| + \log|b| + \log|c| = 0$, then the maximum possible value of $a + b + c$ would be:
- A. 10
 - B. 0
 - C. 3
 - D. -1
75. A person covers half the distance of his total journey by train at 60 km/h, half of the remainder by bus at 30 km/h and the rest by cycle at 10 km/h. His average speed for the entire journey would be:
- A. 24 km/h
 - B. 40 km/h
 - C. 28 km/h
 - D. 30 km/h
76. A vessel originally contains 10 liters of pure alcohol. From this container 1 liter of the alcohol is replaced with 1 liter of water. Later, 1 litre of the mixture in the vessel is again replaced with 1 liter of water and this the process is repeated one more time. The volume of alcohol remaining in the vessel would be:
- A. 7.84 liters
 - B. 8.10 liters
 - C. 7.29 liters

D. 7.20 liters

77. Rani purchased roses by paying Rs. 600, Rita purchased a red dress by paying Rs. 900 and Roja purchased a ring by paying Rs. 1200. All these gifts were presented to Ramya on her birthday. However, the three friends except the birthday girl, wanted to share the total cost of gifts equally. For this following needs to be done
- A. every one pays Rs. 900 to Ramya
 - B. Rani pays 300 Rs to Roja
 - C. Rita pays 300 Rs to Ramya
 - D. Rita pays 300 Rs to Rani
78. If a recipe for 5 servings uses $\frac{2}{3}$ rd cup of sugar and you want to make the dish for 4 servings, then how much sugar do you need?
- A. $(\frac{8}{15})^{th}$ cup
 - B. $(\frac{5}{6})^{th}$ cup
 - C. $(\frac{3}{4})^{th}$ cup
 - D. $(\frac{9}{10})^{th}$ cup
79. If a book originally cost Rs. 440 and is now on sale for 30% off for the first 3 copies purchased. Any additional copy will have a discount of 40%. Ram purchased 10 books. What is the total bill amount after considering 18% GST on the discounted cost?
- A. Rs. 4400
 - B. Rs. 1848
 - C. Rs. 2772
 - D. Rs. 3271
80. A man enters a magical river with some unknown number of leaves in his hand. He takes a dip in the river and the leaves multiply by 2 and increase by 3 new leaves. Excited by this magic, he takes 5 more dips in the river. Every time the same effect is observed, the leaves double and 3 new leaves get added to the number of leaves before taking the dip. If finally he has 253 leaves, then how many leaves did he start with?
- A. 4
 - B. 5
 - C. 7
 - D. None of the above

6 Reasoning

10 marks

81. Among 25 persons present in a room, 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is:
- A. 3
 - B. 8
 - C. 17
 - D. 5

82. If $136+277=435$, then how much is $731+672$ equal to:
- A. 1623
 - B. 1423
 - C. 897
 - D. 2199
83. 5 skilled workers can build a wall in 20 days, while 8 semi-skilled workers can build the same wall in 25 days, and 10 unskilled workers can build the wall in 30 days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?
- A. 12
 - B. 18
 - C. 15
 - D. 10
84. Four locations M, N, O and P are such that, M is north of N at a distance of 4 km; P is south of O at a distance of 2 km; N is southeast of O by 1 km. Which of the following could be the distance between M and P?
- A. 5.5 km
 - B. 6.5 km
 - C. 6.9 km
 - D. 7.2 km
85. There are four bags each containing identical sets of ten distinct chocolates. One chocolate is picked from each bag. The probability that at least two chocolates are identical is approximately:
- A. 0.6
 - B. 0.7
 - C. 0.4
 - D. 0.5
86. Arrange the following words in alphabetical order: Orange, Apple, Grapes, Apricot
- A. Apple, Apricot, Grapes, Orange
 - B. Apricot, Apple, Grapes, Orange
 - C. Apple, Grapes, Banana, Apricot
 - D. Grapes, Orange, Apricot, Apple
87. Statement 1: Every candidate applying for a job passed the written test. Statement 2: Lisa did not pass the written test. Then the conclusion is ...
- A. Lisa already has a job
 - B. Lisa's job application form was incomplete
 - C. Statement 2 is wrong
 - D. Lisa did not apply for the job
88. Among a group of 58 people, 38 like reading books, 23 like watching YouTube, and 10 like both activities. How many people like only watching YouTube?

- A. 7
- B. 13
- C. 20
- D. 28

89. Consider three sets:

$$A = \{8, 18, 27, 32, 40, 44, 67, 89\},$$

$$B = \{14, 19, 27, 32, 37, 44, 51\}, \text{ and}$$

$$C = \{19, 23, 27, 33, 40, 44, 51\}. \text{ Find intersection of all three sets.}$$

- A. $\{27, 44\}$
- B. $\{27, 40, 44\}$
- C. $\{32, 44, 51\}$
- D. none of the above

90. Raju said to Swapna, "Your mother's brother is the only son of my uncle." How is Raju related to Swapna?

- A. Brother
- B. Uncle
- C. Nephew
- D. Father

7 General English

10 marks

91. Among the following, identify the most appropriate sentence with respect to grammar and usage.

- A. I will not leave the place until the minister does not meet me.
- B. I will not leave the place until the minister don't meet me.
- C. I will not leave the place until the minister meet me.
- D. I will not leave the place until the minister meets me.

92. Choose the most appropriate word to fill in the blank in the following sentence.

"I cannot support this proposal. My _____ will not permit it."

- A. conscious
- B. consent
- C. consensus
- D. conscience

93. Choose the most appropriate word to fill in the blank in the following sentence.

"We reached the station late, and _____ missed the train."

- A. near
- B. nearly
- C. mostly
- D. almostly

94. Choose the most appropriate analogy for the following.
Courts : _____ :: Parliament : Legislature
- A. Judiciary
 - B. Law
 - C. Magistrate
 - D. Executive
95. Choose the grammatically the correct sentence:
- A. She don't like the pizza.
 - B. She not like pizza.
 - C. She isn't like pizza.
 - D. She doesn't like pizza.
96. Choose the correct spelling:
- A. Accomodate
 - B. Acommodate
 - C. Accommodate
 - D. Acomodate
97. Identify the correct definition for "ubiquitous":
- A. Limited
 - B. Scarce
 - C. Present everywhere
 - D. Isolated
98. Choose the sentence with the correct usage:
- A. Their going to the party over there.
 - B. There going to the party, they are excited.
 - C. They are going to the party over there.
 - D. They are partying, their happy.
99. Put the following sentences in the **reverse** order to narrate a journey:
- p) The landscape outside the window changed rapidly.
 - q) The train halted midway due to a technical snag.
 - r) The vending machine dispensed tickets to the passengers.
 - s) Passengers settled into their seats.
- A. r,s,q,p
 - B. r,s,p,q
 - C. q,p,r,s
 - D. q,p,s,r
100. Identify the sentence with proper subject-verb agreement:
- A. The cars parked in the lot needs maintenance.

- B. A large group of birds is flying overhead.
 - C. The information on the website are accurate.
 - D. Nobody in the room know the answer.
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