GATE 2014: General Instructions during Examination

1. Total duration of the GATE examination is **180** minutes.
2. The clock will be set at the server. The countdown timer at the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You need not terminate the examination or submit your paper.
3. Any useful data required for your paper can be viewed by clicking on the **Useful Common Data** button that appears on the screen.
4. Use the scribble pad provided to you for any rough work. Submit the scribble pad at the end of the examination.
5. You are allowed to use a non-programmable type calculator, however, sharing of calculators is not allowed.
6. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

1	You have not visited the question yet.
3	You have not answered the question.
5	You have answered the question.
7	You have NOT answered the question, but have marked the question for review.
9	You have answered the question, but marked it for review.

The **Marked for Review** status for a question simply indicates that you would like to look at that question again. *If a question is answered, but marked for review, then the answer will be considered for evaluation unless the status is modified by the candidate.*

Navigating to a Question :

7. To answer a question, do the following:
   a. Click on the question number in the Question Palette to go to that question directly.
   b. Select an answer for a multiple choice type question by clicking on the bubble placed before the 4 choices, namely A, B, C and D. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
   c. Click on **Save & Next** to save your answer for the current question and then go to the next question.
   d. Click on **Mark for Review & Next** to save your answer for the current question and also mark it for review, and then go to the next question.

Caution: Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on a question number without saving the answer to the previous question.

You can view all the questions by clicking on the **Question Paper** button. This feature is provided, so that if you want you can just see the entire question paper at a glance.

Answering a Question :

8. Procedure for answering a multiple choice (MCQ) type question:
   a. Choose one answer from the 4 options (A,B,C,D) given below the question, click on the bubble placed before the chosen option.
   b. To deselect your chosen answer, click on the bubble of the chosen option again or click on the **Clear Response** button.
   c. To change your chosen answer, click on the bubble of another option.
   d. To save your answer, you MUST click on the **Save & Next** button.

9. Procedure for answering a numerical answer type question:
   a. To enter a number as your answer, use the virtual numerical keypad.
   b. A fraction (e.g. -0.3 or -.3) can be entered as an answer with or without '0' before the decimal point. As many as four decimal points, e.g. 12.5435 or 0.003 or -932.6711 or 12.82 can be entered.
   c. To clear your answer, click on the **Clear Response** button.
   d. To save your answer, you MUST click on the **Save & Next** button

10. To mark a question for review, click on the **Mark for Review & Next** button. *If an answer is selected (for MCQ) or entered (for numerical answer type) for a question that is* **Marked for Review**, *that answer will be considered in the evaluation unless the status is modified by the candidate.*

11. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.

12. Note that ONLY Questions for which answers are *saved* or *marked for review after answering* will be considered for evaluation.

Choosing a Section :

13. Sections in this question paper are displayed on the top bar of the screen. Questions in a Section can be viewed by clicking on the name of that Section. The Section you are currently viewing will be highlighted.

14. A checkbox is displayed for every optional Section, if any, in the Question Paper. To select the optional Section for answering, click on the checkbox for that Section.

15. If the checkbox for an optional Section is not selected, the **Save & Next** button and the **Mark for Review & Next** button will NOT be enabled for that Section. You will

only be able to see questions in this Section, but you will not be able to answer questions in the Section.

16. After clicking the **Save & Next** button for the last question in a Section, you will automatically be taken to the first question of the next Section in sequence.

17. You can move the mouse cursor over the name of a Section to view the answering status for that Section.

Changing the Optional Section :

18. After answering the chosen optional Section, partially or completely, you can change the optional Section by selecting the checkbox for a new Section that you want to attempt. A warning message will appear along with a table showing the number of questions answered in each of the previously chosen optional Sections and a checkbox against each of these Sections. Click on a checkbox against a Section that you want to reset and then click on the **RESET** button. Note that RESETTING a Section will DELETE all the answers for questions in that Section. Hence, if you think that you may want to select this Section again later, you will have to note down your answers for questions in that Section. If you do not want to reset the Section and want to continue answering the previously chosen optional Section, then click on the **BACK** button.

19. If you deselect the checkbox for an optional Section in the top bar, the following warning message will appear: "Deselecting the checkbox will DELETE all the answers for questions in this Section. Do you want to deselect this Section?" If you want to deselect, click on the **RESET** button. If you do not want to deselect, click on the **BACK** button.

20. You can shuffle between different Sections or change the optional Sections any number of times.

GATE 2014 Examination

EC: Electronics & Communications Engineering

Duration: **180 minutes**   *Maximum Marks*: **100**

Read the following instructions carefully.

1. To login, enter your Registration Number and password provided to you. Kindly go through the various symbols used in the test and understand their meaning before you start the examination.
2. Once you login and after the start of the examination, you can view all the questions in the question paper, by clicking on the **View All Questions** button in the screen.
3. This question paper consists of **2 sections**, General Aptitude (GA) for **15 marks** and the subject specific GATE paper for **85 marks**. Both these sections are compulsory.
   The GA section consists of **10** questions. Question numbers 1 to 5 are of 1-mark each, while question numbers 6 to 10 are of 2-mark each.
   The subject specific GATE paper section consists of **55** questions, out of which question numbers 1 to 25 are of 1-mark each, while question numbers 26 to 55 are of 2-mark each.
4. Depending upon the GATE paper, there may be useful common data that may be required for answering the questions. If the paper has such useful data, the same can be viewed by clicking on the **Useful Common Data** button that appears at the top, right hand side of the screen.

5. The computer allotted to you at the examination center runs specialized software that permits only one answer to be selected for multiple-choice questions using a mouse and to enter a suitable number for the numerical answer type questions using the virtual keyboard and mouse.
6. Your answers shall be updated and saved on a server periodically and also at the end of the examination. The examination will **stop automatically** at the end of **180 minutes**.
7. In each paper a candidate can answer a total of 65 questions carrying 100 marks.
8. The question paper may consist of questions of **multiple choice type** (MCQ) and **numerical answer type**.
9. Multiple choice type questions will have four choices against A, B, C, D, out of which only **ONE** is the correct answer. The candidate has to choose the correct answer by clicking on the bubble (◯) placed before the choice.
10. For numerical answer type questions, each question will have a numerical answer and there will not be any choices**. For these questions, the answer should be entered**by using the virtual keyboard that appears on the monitor and the mouse.
11. All questions that are not attempted will result in zero marks. However, wrong answers for multiple choice type questions (MCQ) will result in **NEGATIVE** marks. For all MCQ questions a wrong answer will result in deduction of⅓ marks for a 1-mark question and ⅔ marks for a 2-mark question.
12. There is **NO NEGATIVE MARKING** for questions of **NUMERICAL ANSWER TYPE**.

13. Non-programmable type Calculator is allowed. Charts, graph sheets, and mathematical tables are **NOT** allowed in the Examination Hall. You must use the Scribble pad provided to you at the examination centre for all your rough work. The Scribble Pad has to be returned at the end of the examination.

Declaration by the candidate:

"I have read and understood all the above instructions. I have also read and understood clearly the instructions given on the admit card and shall follow the same. I also understand that in case I am found to violate any of these instructions, my candidature is liable to be cancelled. I also confirm that at the start of the examination all the computer hardware allotted to me are in proper working condition".
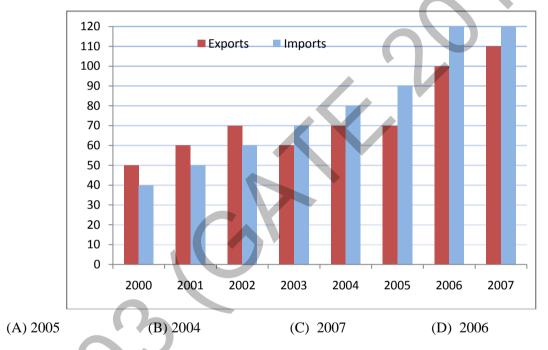
Q. 1 – Q. 5 carry one mark each.

Q.1   Choose the most appropriate phrase from the options given below to complete the following sentence.

The aircraft _____ take off as soon as its flight plan was filed.

(A) is allowed to   (B) will be allowed to
(C) was allowed to   (D) has been allowed to

Q.2   Read the statements:

All women are entrepreneurs.
Some women are doctors.

Which of the following conclusions can be logically inferred from the above statements?

(A) All women are doctors   (B) All doctors are entrepreneurs
(C) All entrepreneurs are women   (D) Some entrepreneurs are doctors

Q.3   Choose the most appropriate word from the options given below to complete the following sentence.

Many ancient cultures attributed disease to supernatural causes. However, modern science has largely helped _____ such notions.

(A) impel   (B) dispel   (C) propel   (D) repel

Q.4   The statistics of runs scored in a series by four batsmen are provided in the following table. Who is the most <u>consistent</u> batsman of these four?

Batsman	Average	Standard deviation
K	31.2	5.21
L	46.0	6.35
M	54.4	6.22
N	17.9	5.90

(A) K   (B) L   (C) M   (D) N

Q.5   What is the next number in the series?

12   35   81   173   357   ____

Q. 6 – Q. 10 carry two marks each.

Q.6   Find the odd one from the following group:

W,E,K,O   I,Q,W,A   F,N,T,X   N,V,B,D

(A) W,E,K,O   (B) I,Q,W,A   (C) F,N,T,X   (D) N,V,B,D

Q.7   For submitting tax returns, all resident males with annual income below Rs 10 lakh should fill up Form P and all resident females with income below Rs 8 lakh should fill up Form Q. All people with incomes above Rs 10 lakh should fill up Form R, except non residents with income above Rs 15 lakhs, who should fill up Form S. All others should fill Form T. An example of a person who should fill Form T is

(A) a resident male with annual income Rs 9 lakh
(B) a resident female with annual income Rs 9 lakh
(C) a non-resident male with annual income Rs 16 lakh
(D) a non-resident female with annual income Rs 16 lakh

Q.8   A train that is 280 metres long, travelling at a uniform speed, crosses a platform in 60 seconds and passes a man standing on the platform in 20 seconds. What is the length of the platform in metres?

Q.9   The exports and imports (in crores of Rs.) of a country from 2000 to 2007 are given in the following bar chart. If the trade deficit is defined as excess of imports over exports, in which year is the trade deficit 1/5th of the exports?

(A) 2005   (B) 2004   (C) 2007   (D) 2006

Q.10   You are given three coins: one has heads on both faces, the second has tails on both faces, and the third has a head on one face and a tail on the other. You choose a coin at random and toss it, and it comes up heads. The probability that the other face is tails is
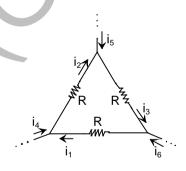
(A) 1/4   (B) 1/3   (C) 1/2   (D) 2/3

END OF THE QUESTION PAPER

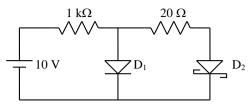## Q. 1 – Q. 25 carry one mark each.

Q.1   For matrices of same dimension *M, N* and scalar *c*, which one of these properties DOES NOT ALWAYS hold?

(A)$(M^T)^T = M$
(B) $(cM)^T = c(M)^T$
(C) $(M + N)^T = M^T + N^T$
(D) $MN = NM$

Q.2   In a housing society, half of the families have a single child per family, while the remaining half have two children per family. The probability that a child picked at random, has a sibling is _____

Q.3 C is a closed path in the z-plane given by $|z| = 3$. The value of the integral $\oint_C \left(\frac{z^2 - z + 4j}{z + 2j} \right) dz$ is

(A) $-4\pi(1 + j2)$ (B) $4\pi(3 - j2)$ (C) $-4\pi(3 + j2)$ (D) $4\pi(1 - j2)$

Q.4   A real (4×4) matrix A satisfies the equation $A^2 = I$, where I is the (4×4) identity matrix. The positive eigen value of A is _____.

Q.5   Let $X_1, X_2,$ and X_3 be independent and identically distributed random variables with the uniform distribution on [0, 1]. The probability $P\{X_1$ is the largest$\}$ is _____

Q.6   For maximum power transfer between two cascaded sections of an electrical network, the relationship between the output impedance Z_1 of the first section to the input impedance Z_2 of the second section is

(A) $Z_2 = Z_1$ (B) $Z_2 = -Z_1$ (C) $Z_2 = Z_1^*$ (D) $Z_2 = -Z_1^*$

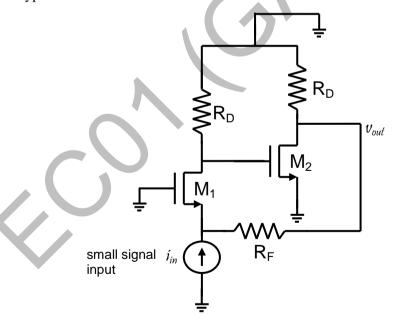Q.7   Consider the configuration shown in the figure which is a portion of a larger electrical network

For R = 1 Ω and currents $i_1 = 2$ A, $i_4 = -1$ A, $i_5 = -4$ A, which one of the following is **TRUE?**

(A) $i_6 = 5 A$
(B) $i_3 = -4 A$
(C) Data is sufficient to conclude that the supposed currents are impossible
(D) Data is insufficient to identify the currents $i_2, i_3,$ and i_6

Q.8   When the optical power incident on a photodiode is 10μW and the responsivity is 0.8 A/W, the photocurrent generated (in μA) is _____.
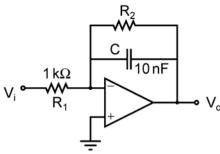
Q.9   In the figure, assume that the forward voltage drops of the PN diode D_1 and Schottky diode D_2 are 0.7 V and 0.3 V, respectively. If ON denotes conducting state of the diode and OFF denotes non-conducting state of the diode, then in the circuit,

(A) both D_1 and D_2 are ON
(B) D_1 is ON and D_2 is OFF
(C) both D_1 and D_2 are OFF
(D) D_1 is OFF and D_2 is ON

Q.10   If fixed positive charges are present in the gate oxide of an n-channel enhancement type MOSFET, it will lead to

(A) a decrease in the threshold voltage
(B) channel length modulation
(C) an increase in substrate leakage current
(D) an increase in accumulation capacitance

Q.11   A good current buffer has

(A) low input impedance and low output impedance
(B) low input impedance and high output impedance
(C) high input impedance and low output impedance
(D) high input impedance and high output impedance

Q.12   In the ac equivalent circuit shown in the figure, if i_{in} is the input current and R_F is very large, the type of feedback is
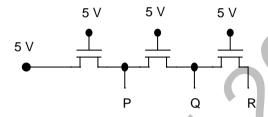

(A) voltage-voltage feedback
(B) voltage-current feedback
(C) current-voltage feedback
(D) current-current feedback

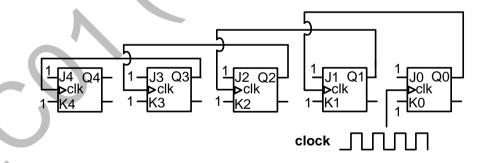Q.13   In the low-pass filter shown in the figure, for a cut-off frequency of 5 kHz , the value of R_2 (in kΩ) is _____.

Q.14   In the following circuit employing pass transistor logic, all NMOS transistors are identical with a threshold voltage of 1 V. Ignoring the body-effect, the output voltages at P, Q and R are,

(A) 4 V, 3 V, 2 V
(B) 5 V, 5 V, 5 V
(C) 4 V, 4 V, 4 V
(D) 5 V, 4 V, 3 V

Q.15   The Boolean expression $(X + Y) (X + \overline{Y}) + \overline{(X\overline{Y})} + \overline{X}$ simplifies to

(A) X   (B) Y   (C) XY   (D) X+Y

Q.16   Five JK flip-flops are cascaded to form the circuit shown in Figure. Clock pulses at a frequency of 1 MHz are applied as shown. The frequency (in kHz) of the waveform at **Q3** is _____ .

Q.17   A discrete-time signal $x[n] = \sin(\pi^2 n)$, n being an integer, is

(A) periodic with period π.   (B) periodic with period π^2.
(C) periodic with period $\pi/2$.   (D) not periodic.

Q.18   Consider two real valued signals, $x(t)$ band-limited to $[-500 \text{ Hz}, 500 \text{ Hz}]$ and $y(t)$ band-limited to $[-1 \text{ kHz}, 1 \text{ kHz}]$. For $z(t) = x(t) \cdot y(t)$, the Nyquist sampling frequency (in kHz) is _____.

Q.19   A continuous, linear time-invariant filter has an impulse response $h(t)$ described by

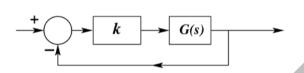$$h(t) = \begin{cases} 3 & \text{for } 0 \leq t \leq 3 \\ 0 & \text{otherwise} \end{cases}$$

When a constant input of value 5 is applied to this filter, the steady state output is _____.
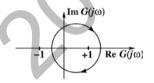
Q.20   The forward path transfer function of a unity negative feedback system is given by

$$G(s) = \frac{K}{(s+2)(s-1)}$$

The value of K which will place both the poles of the closed-loop system at the same location, is _____ .

Q.21   Consider the feedback system shown in the figure. The Nyquist plot of $G(s)$ is also shown. Which one of the following conclusions is correct?

(A) $G(s)$ is an all-pass filter
(B) $G(s)$ is a strictly proper transfer function
(C) $G(s)$ is a stable and minimum-phase transfer function
(D) The closed-loop system is unstable for sufficiently large and positive k

Q.22   In a code-division multiple access (CDMA) system with $N = 8$ chips, the maximum number of users who can be assigned mutually orthogonal signature sequences is _____

Q.23   The capacity of a Binary Symmetric Channel (BSC) with cross-over probability 0.5 is _____

Q.24
A two-port network has scattering parameters given by $[S] = \begin{bmatrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{bmatrix}$. If the port-2 of the two-

port is short circuited, the s_{11} parameter for the resultant one-port network is

(A) $\dfrac{s_{11} - s_{11}s_{22} + s_{12}s_{21}}{1 + s_{22}}$

(B) $\dfrac{s_{11} + s_{11}s_{22} - s_{12}s_{21}}{1 + s_{22}}$

(C) $\dfrac{s_{11} + s_{11}s_{22} + s_{12}s_{21}}{1 - s_{22}}$

(D) $\dfrac{s_{11} - s_{11}s_{22} + s_{12}s_{21}}{1 - s_{22}}$

Q.25   The force on a point charge $+q$ kept at a distance d from the surface of an infinite grounded metal plate in a medium of permittivity ϵ is

(A) 0

(B) $\dfrac{q^2}{16\pi \epsilon d^2}$ away from the plate

(C) $\dfrac{q^2}{16\pi \epsilon d^2}$ towards the plate

(D) $\dfrac{q^2}{4\pi \epsilon d^2}$ towards the plate

Q. 26 – Q. 55 carry two marks each.

Q.26 The Taylor series expansion of $3\sin x + 2\cos x$ is

(A) $2 + 3x - x^2 - \dfrac{x^3}{2} + \ldots$

(B) $2 - 3x + x^2 - \dfrac{x^3}{2} + \ldots$

(C) $2 + 3x + x^2 + \dfrac{x^3}{2} + \ldots$

(D) $2 - 3x - x^2 + \dfrac{x^3}{2} + \ldots$

Q.27 For a function $g(t)$, it is given that $\int_{-\infty}^{+\infty} g(t)e^{-j\omega t}\,dt = \omega e^{-2\omega^2}$ for any real value ω.
If $y(t) = \int_{-\infty}^{t} g(\tau)\,d\tau$, then $\int_{-\infty}^{+\infty} y(t)dt$ is

(A) 0 (B) $-j$ (C) $-\dfrac{j}{2}$ (D) $\dfrac{j}{2}$

Q.28 The volume under the surface $z(x,y) = x + y$ and above the triangle in the x-y plane defined by $\{0 \le y \le x$ and $0 \le x \le 12\}$ is _____.

Q.29 Consider the matrix

$$J_6 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

which is obtained by reversing the order of the columns of the identity matrix I_6.
Let $P = I_6 + \alpha J_6$, where α is a non-negative real number. The value of α for which $\det(P) = 0$ is _____.

Q.30 A Y-network has resistances of 10Ω each in two of its arms, while the third arm has a resistance of 11Ω. In the equivalent Δ-network, the lowest value (in Ω) among the three resistances is _____.

Q.31 A 230 V rms source supplies power to two loads connected in parallel. The first load draws 10 kW at 0.8 leading power factor and the second one draws 10 kVA at 0.8 lagging power factor. The complex power delivered by the source is
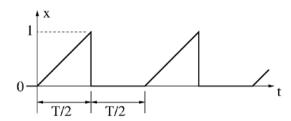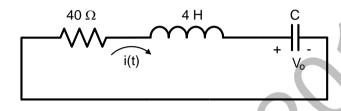
(A) $(18 + j\,1.5)$ kVA (B) $(18 - j\,1.5)$ kVA
(C) $(20 + j\,1.5)$ kVA (D) $(20 - j\,1.5)$ kVA

Q.32   A periodic variable x is shown in the figure as a function of time. The root-mean-square (rms) value of x is _____.
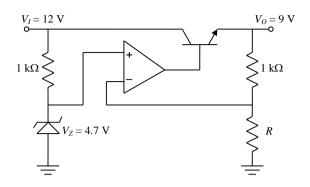

Q.33   In the circuit shown in the figure, the value of capacitor C (in mF) needed to have critically damped response i(t) is _____.
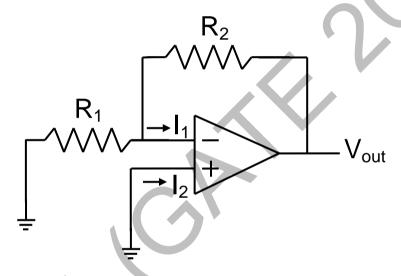

Q.34   A BJT is biased in forward active mode. Assume $V_{BE} = 0.7$ V, $kT/q = 25$ mV and reverse saturation current $I_S = 10^{-13}$ A. The transconductance of the BJT (in mA/V) is _____.

Q.35   The doping concentrations on the p-side and n-side of a silicon diode are 1×10^{16} cm^{-3} and 1×10^{17} cm^{-3}, respectively. A forward bias of 0.3 V is applied to the diode. At T = 300 K, the intrinsic carrier concentration of silicon $n_i = 1.5 \times 10^{10}$ cm^{-3} and $\frac{kT}{q} = 26$ mV. The electron concentration at the edge of the depletion region on the p-side is

(A) 2.3×10^9 cm^{-3}
(B) 1×10^{16} cm^{-3}
(C) 1×10^{17} cm^{-3}
(D) 2.25×10^6 cm^{-3}

Q.36   A depletion type N-channel MOSFET is biased in its linear region for use as a voltage controlled resistor. Assume threshold voltage $V_{TH} = -0.5$ V, $V_{GS} = 2.0$ V, $V_{DS} = 5$ V, W/L = 100, $C_{ox} = 10^{-8}$ F/cm^2 and $\mu_n = 800$ cm^2/V-s. The value of the resistance of the voltage controlled resistor (in Ω) is _____.

Q.37   In the voltage regulator circuit shown in the figure, the op-amp is ideal. The BJT has $V_{BE} = 0.7$ V and $\beta = 100$, and the zener voltage is 4.7 V. For a regulated output of 9 V, the value of R (in Ω) is _____.
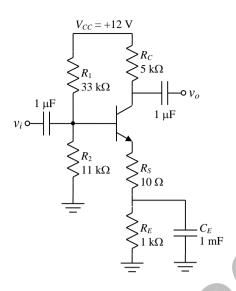

Q.38   In the circuit shown, the op-amp has finite input impedance, infinite voltage gain and zero input offset voltage. The output voltage V_{out} is
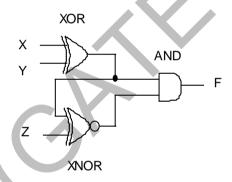

(A $-I_2(R_1 + R_2)$

(B) $I_2 R_2$

(C)) $I_1 R_2$

(D) $-I_1(R_1 + R_2)$

Q.39 For the amplifier shown in the figure, the BJT parameters are $V_{BE} = 0.7$ V, $\beta = 200$, and thermal voltage $V_T = 25$ mV. The voltage gain (v_o/v_i) of the amplifier is _____ .
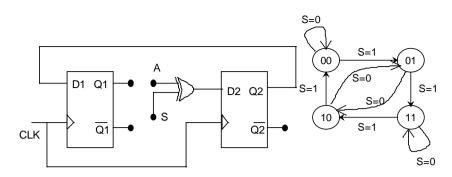

Q.40 The output F in the digital logic circuit shown in the figure is

(A) $F = \bar{X}YZ + X\bar{Y}Z$
(B) $F = \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z}$
(C) $F = \bar{X}\bar{Y}Z + XYZ$
(D) $F = \bar{X}\bar{Y}\bar{Z} + XYZ$

Q.41 Consider the Boolean function, $F(w, x, y, z) = wy + xy + \bar{w}xyz + \bar{w}\bar{x}y + xz + \bar{x}\bar{y}\bar{z}$. Which one of the following is the complete set of essential prime implicants?

(A) $w, y, xz, \bar{x}\bar{z}$
(B) w, y, xz
(C) $y, \bar{x}\bar{y}\bar{z}$
(D) $y, xz, \bar{x}\bar{z}$

Q.42   The digital logic shown in the figure satisfies the given state diagram when Q1 is connected to input A of the XOR gate.

Suppose the XOR gate is replaced by an XNOR gate. Which one of the following options preserves the state diagram?

(A) Input A is connected to $\overline{Q2}$
(B) Input A is connected to $Q2$
(C) Input A is connected to $\overline{Q1}$ and S is complemented
(D) Input A is connected to $\overline{Q1}$

Q.43   Let $x[n] = \left(-\frac{1}{9}\right)^n u(n) - \left(-\frac{1}{3}\right)^n u(-n-1)$. The Region of Convergence (ROC) of the z-transform of $x[n]$

(A) is $|z| > \frac{1}{9}$.   (B) is $|z| < \frac{1}{3}$.
(C) is $\frac{1}{3} > |z| > \frac{1}{9}$.   (D) does not exist.

Q.44   Consider a discrete time periodic signal $x[n] = sin\left(\frac{\pi n}{5}\right)$. Let a_k be the complex Fourier series coefficients of $x[n]$. The coefficients $\{a_k\}$ are non-zero when $k = Bm \pm 1$, where m is any integer. The value of B is_____.

Q.45   A system is described by the following differential equation, where $u(t)$ is the input to the system and $y(t)$ is the output of the system.

$$\dot{y}(t) + 5y(t) = u(t)$$

When $y(0) = 1$ and $u(t)$ is a unit step function, $y(t)$ is

(A) $0.2 + 0.8e^{-5t}$ (B) $0.2 - 0.2e^{-5t}$ (C) $0.8 + 0.2e^{-5t}$ (D) $0.8 - 0.8e^{-5t}$

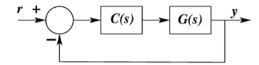Q.46   Consider the state space model of a system, as given below

$$\begin{bmatrix}\dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -2\end{bmatrix}\begin{bmatrix}x_1 \\ x_2 \\ x_3\end{bmatrix} + \begin{bmatrix}0 \\ 4 \\ 0\end{bmatrix} u; \; y = \begin{bmatrix}1 & 1 & 1\end{bmatrix}\begin{bmatrix}x_1 \\ x_2 \\ x_3\end{bmatrix}.$$

The system is

(A) controllable and observable
(B) uncontrollable and observable
(C) uncontrollable and unobservable
(D) controllable and unobservable

Q.47   The phase margin in degrees of $G(s) = \frac{10}{(s+0.1)(s+1)(s+10)}$ calculated using the asymptotic Bode plot is _____.

Q.48   For the following feedback system $G(s) = \frac{1}{(s+1)(s+2)}$. The 2%-settling time of the step response is required to be less than 2 seconds.

Which one of the following compensators $C(s)$ achieves this?

(A $3\left(\frac{1}{s+5}\right)$ (B) $5(\frac{0.03}{s} + 1)$

(C) $2(s + 4)$ (D) $4\left(\frac{s+8}{s+3}\right)$

Q.49   Let X be a real-valued random variable with $E[X]$ and $E[X^2]$ denoting the mean values of X and X^2, respectively. The relation which always holds true is

(A) $(E[X])^2 > E[X^2]$
(B) $E[X^2] \geq (E[X])^2$
(C) $E[X^2] = (E[X])^2$
(D) $E[X^2] > (E[X])^2$

Q.50   Consider a random process $X(t) = \sqrt{2}\sin(2\pi t + \varphi)$, where the random phase φ is uniformly distributed in the interval $[0,2\pi]$. The auto-correlation $E[X(t_1)X(t_2)]$ is
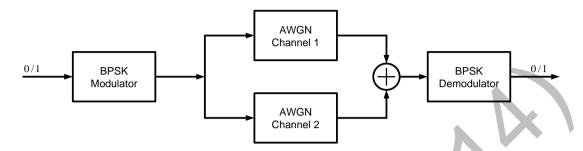
(A) $\cos\left(2\pi(t_1 + t_2)\right)$

(B) $\sin\left(2\pi(t_1 - t_2)\right)$

(C) $\sin\left(2\pi(t_1 + t_2)\right)$

(D) $\cos\left(2\pi(t_1 - t_2)\right)$

Q.51 Let $Q(\sqrt{\gamma})$ be the BER of a BPSK system over an AWGN channel with two-sided noise power spectral density $N_0/2$. The parameter γ is a function of bit energy and noise power spectral density.

A system with two independent and identical AWGN channels with noise power spectral density $N_0/2$ is shown in the figure. The BPSK demodulator receives the sum of outputs of both the channels.

If the BER of this system is $Q(b\sqrt{\gamma})$, then the value of b is _____.

Q.52 A fair coin is tossed repeatedly until a 'Head' appears for the first time. Let L be the number of tosses to get this first 'Head'. The entropy $H(L)$ in bits is _____.

Q.53 In spherical coordinates, let $\hat{a}_\theta, \hat{a}_\phi$ denote unit vectors along the θ, ϕ directions.

$$E = \frac{100}{r}\sin\theta \cos(\omega t - \beta r)\, \hat{a}_\theta V/m$$

and

$$H = \frac{0.265}{r}\sin\theta \cos(\omega t - \beta r)\, \hat{a}_\phi A/m$$

represent the electric and magnetic field components of the EM wave at large distances r from a dipole antenna, in free space. The average power (W) crossing the hemispherical shell located at $r = 1km, 0 \le \theta \le \pi/2$ is _____

Q.54 For a parallel plate transmission line, let v be the speed of propagation and Z be the characteristic impedance. Neglecting fringe effects, a reduction of the spacing between the plates by a factor of two results in

(A) halving of v and no change in Z
(B) no changes in v and halving of Z
(C) no change in both v and Z
(D) halving of both v and Z

Q.55 The input impedance of a $\dfrac{\lambda}{8}$ section of a lossless transmission line of characteristic impedance

$50\,\Omega$ is found to be real when the other end is terminated by a load $Z_L (= R + jX)\Omega$. If X is

$30\,\Omega$, the value of R (in Ω) is _____

END OF THE QUESTION PAPER