

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:



You have not visited the question yet.



You have not answered the question.



You have answered the question.



You have NOT answered the question, but have marked the question for review.



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 of $\frac{1}{3}$ marks for a 1-mark question and $\frac{2}{3}$ 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 word from the options given below to complete the following sentence.

Communication and interpersonal skills are _____ important in their own ways.

- (A) each (B) both (C) all (D) either

- Q.2 Which of the options given below best completes the following sentence?

She will feel much better if she _____.

- (A) will get some rest (B) gets some rest
(C) will be getting some rest (D) is getting some rest

- Q.3 Choose the most appropriate pair of words from the options given below to complete the following sentence.

She could not _____ the thought of _____ the election to her bitter rival.

- (A) bear, loosing (B) bare, loosing (C) bear, losing (D) bare, losing

- Q.4 A regular die has six sides with numbers 1 to 6 marked on its sides. If a very large number of throws show the following frequencies of occurrence: $1 \rightarrow 0.167$; $2 \rightarrow 0.167$; $3 \rightarrow 0.152$; $4 \rightarrow 0.166$; $5 \rightarrow 0.168$; $6 \rightarrow 0.180$. We call this die

- (A) irregular (B) biased (C) Gaussian (D) insufficient

- Q.5 Fill in the missing number in the series.

2 3 6 15 ____ 157.5 630

Q. 6 – Q. 10 carry two marks each.

- Q.6 Find the odd one in the following group

Q,W,Z,B B,H,K,M W,C,G,J M,S,V,X

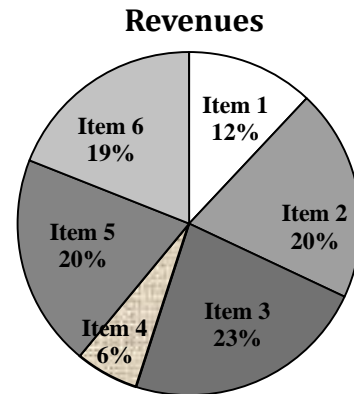
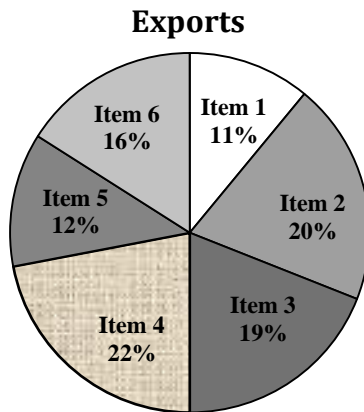
- (A) Q,W,Z,B (B) B,H,K,M (C) W,C,G,J (D) M,S,V,X

- Q.7 Lights of four colors (red, blue, green, yellow) are hung on a ladder. On every step of the ladder there are two lights. If one of the lights is red, the other light on that step will always be blue. If one of the lights on a step is green, the other light on that step will always be yellow. Which of the following statements is not necessarily correct?

- (A) The number of red lights is equal to the number of blue lights
(B) The number of green lights is equal to the number of yellow lights
(C) The sum of the red and green lights is equal to the sum of the yellow and blue lights
(D) The sum of the red and blue lights is equal to the sum of the green and yellow lights

- Q.8 The sum of eight consecutive odd numbers is 656. The average of four consecutive even numbers is 87. What is the sum of the smallest odd number and second largest even number?

- Q.9 The total exports and revenues from the exports of a country are given in the two charts shown below. The pie chart for exports shows the quantity of each item exported as a percentage of the total quantity of exports. The pie chart for the revenues shows the percentage of the total revenue generated through export of each item. The total quantity of exports of all the items is 500 thousand tonnes and the total revenues are 250 crore rupees. Which item among the following has generated the maximum revenue per kg?



- (A) Item 2 (B) Item 3 (C) Item 6 (D) Item 5
- Q.10 It takes 30 minutes to empty a half-full tank by draining it at a constant rate. It is decided to simultaneously pump water into the half-full tank while draining it. What is the rate at which water has to be pumped in so that it gets fully filled in 10 minutes?
- (A) 4 times the draining rate (B) 3 times the draining rate
(C) 2.5 times the draining rate (D) 2 times the draining rate

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each.

Q.1 The determinant of matrix A is 5 and the determinant of matrix B is 40. The determinant of matrix AB is _____.

Q.2 Let X be a random variable which is uniformly chosen from the set of positive odd numbers less than 100. The expectation, $E[X]$, is _____.

Q.3 For $0 \leq t < \infty$, the maximum value of the function $f(t) = e^{-t} - 2e^{-2t}$ occurs at
 (A) $t = \log_e 4$ (B) $t = \log_e 2$ (C) $t = 0$ (D) $t = \log_e 8$

Q.4 The value of

$$\lim_{x \rightarrow \infty} \left(1 + \frac{1}{x}\right)^x$$

is

(A) $\ln 2$ (B) 1.0 (C) e (D) ∞

Q.5 If the characteristic equation of the differential equation

$$\frac{d^2 y}{dx^2} + 2\alpha \frac{dy}{dx} + y = 0$$

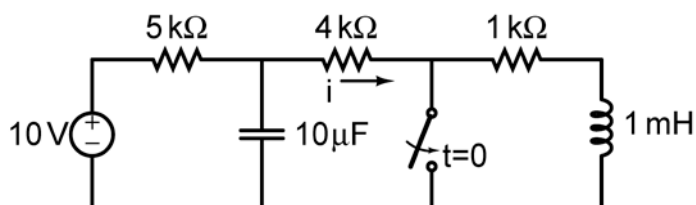
has two equal roots, then the values of α are

(A) ± 1 (B) 0,0 (C) $\pm j$ (D) $\pm 1/2$

Q.6 Norton's theorem states that a complex network connected to a load can be replaced with an equivalent impedance

(A) in series with a current source
 (B) in parallel with a voltage source
 (C) in series with a voltage source
 (D) in parallel with a current source

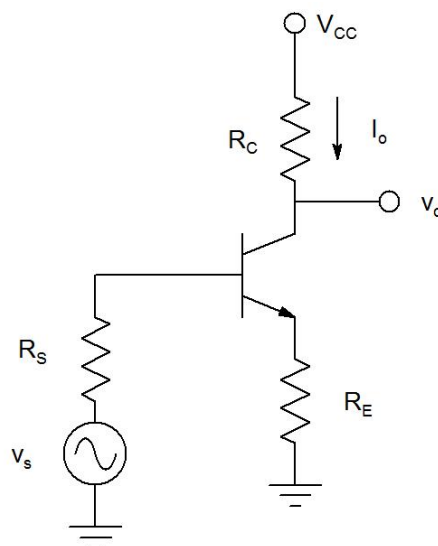
Q.7 In the figure shown, the ideal switch has been open for a long time. If it is closed at $t = 0$, then the magnitude of the current (in mA) through the $4 \text{ k}\Omega$ resistor at $t = 0^+$ is _____.



Q.8 A silicon bar is doped with donor impurities $N_D = 2.25 \times 10^{15} \text{ atoms/cm}^3$. Given the intrinsic carrier concentration of silicon at $T = 300 \text{ K}$ is $n_i = 1.5 \times 10^{10} \text{ cm}^{-3}$. Assuming complete impurity ionization, the equilibrium electron and hole concentrations are

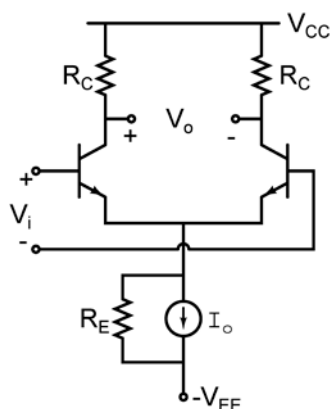
(A) $n_0 = 1.5 \times 10^{16} \text{ cm}^{-3}$, $p_0 = 1.5 \times 10^5 \text{ cm}^{-3}$
 (B) $n_0 = 1.5 \times 10^{10} \text{ cm}^{-3}$, $p_0 = 1.5 \times 10^{15} \text{ cm}^{-3}$
 (C) $n_0 = 2.25 \times 10^{15} \text{ cm}^{-3}$, $p_0 = 1.5 \times 10^{10} \text{ cm}^{-3}$
 (D) $n_0 = 2.25 \times 10^{15} \text{ cm}^{-3}$, $p_0 = 1 \times 10^5 \text{ cm}^{-3}$

- Q.9 An increase in the base recombination of a BJT will increase
- (A) the common emitter dc current gain β
 - (B) the breakdown voltage BV_{CEO}
 - (C) the unity-gain cut-off frequency f_T
 - (D) the transconductance g_m
- Q.10 In CMOS technology, shallow P-well or N-well regions can be formed using
- (A) low pressure chemical vapour deposition
 - (B) low energy sputtering
 - (C) low temperature dry oxidation
 - (D) low energy ion-implantation
- Q.11 The feedback topology in the amplifier circuit (the base bias circuit is not shown for simplicity) in the figure is



- (A) Voltage shunt feedback
- (B) Current series feedback
- (C) Current shunt feedback
- (D) Voltage series feedback

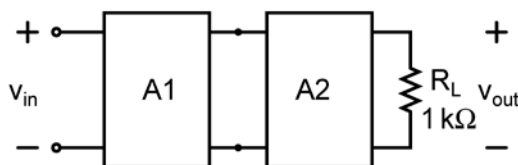
- Q.12 In the differential amplifier shown in the figure, the magnitudes of the common-mode and differential-mode gains are A_{cm} and A_d , respectively. If the resistance R_E is increased, then



- (A) A_{cm} increases
(B) common-mode rejection ratio increases
(C) A_d increases
(D) common-mode rejection ratio decreases
- Q.13 A cascade connection of two voltage amplifiers A1 and A2 is shown in the figure. The open-loop gain A_{v0} , input resistance R_{in} , and output resistance R_o for A1 and A2 are as follows:

A1: $A_{v0} = 10$, $R_{in} = 10 \text{ k}\Omega$, $R_o = 1 \text{ k}\Omega$.
A2: $A_{v0} = 5$, $R_{in} = 5 \text{ k}\Omega$, $R_o = 200 \Omega$.

The approximate overall voltage gain v_{out}/v_{in} is _____.



- Q.14 For an n -variable Boolean function, the maximum number of prime implicants is
(A) $2(n-1)$ (B) $n/2$ (C) 2^n (D) $2^{(n-1)}$
- Q.15 The number of bytes required to represent the decimal number 1856357 in packed BCD (Binary Coded Decimal) form is _____.
- Q.16 In a half-subtractor circuit with X and Y as inputs, the Borrow (M) and Difference ($N = X - Y$) are given by
(A) $M = X \oplus Y$, $N = XY$
(B) $M = XY$, $N = X \oplus Y$
(C) $M = \bar{X}Y$, $N = X \oplus Y$
(D) $M = X\bar{Y}$, $N = \bar{X} \oplus \bar{Y}$
- Q.17 An FIR system is described by the system function

$$H(z) = 1 + \frac{7}{2}z^{-1} + \frac{3}{2}z^{-2}$$

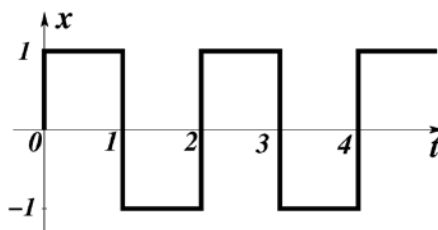
The system is

- (A) maximum phase (B) minimum phase (C) mixed phase (D) zero phase

Q.18 Let $x[n] = x[-n]$. Let $X(z)$ be the z-transform of $x[n]$. If $0.5 + j 0.25$ is a zero of $X(z)$, which one of the following must also be a zero of $X(z)$.

- (A) $0.5 - j 0.25$ (B) $1/(0.5 + j 0.25)$ (C) $1/(0.5 - j 0.25)$ (D) $2 + j 4$

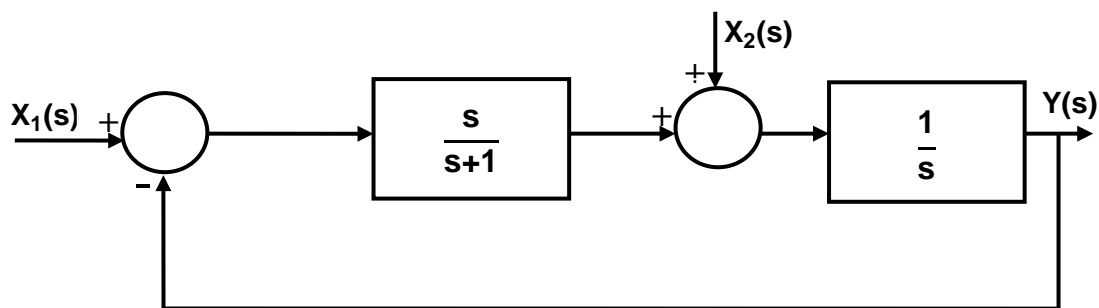
Q.19 Consider the periodic square wave in the figure shown.



The ratio of the power in the 7th harmonic to the power in the 5th harmonic for this waveform is closest in value to _____.

Q.20 The natural frequency of an undamped second-order system is 40 rad/s. If the system is damped with a damping ratio 0.3, the damped natural frequency in rad/s is _____.

Q.21 For the following system,



when $X_1(s) = 0$, the transfer function $\frac{Y(s)}{X_2(s)}$ is

- (A) $\frac{s+1}{s^2}$ (B) $\frac{1}{s+1}$ (C) $\frac{s+2}{s(s+1)}$ (D) $\frac{s+1}{s(s+2)}$

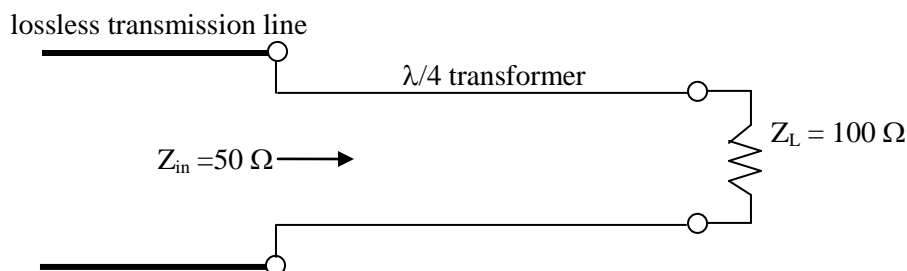
Q.22 The capacity of a band-limited additive white Gaussian noise (AWGN) channel is given by $C = W \log_2 \left(1 + \frac{P}{\sigma^2 W} \right)$ bits per second (bps), where W is the channel bandwidth, P is the average power received and σ^2 is the one-sided power spectral density of the AWGN.

For a fixed $\frac{P}{\sigma^2} = 1000$, the channel capacity (in kbps) with infinite bandwidth ($W \rightarrow \infty$) is approximately

- (A) 1.44 (B) 1.08 (C) 0.72 (D) 0.36

Q.23 Consider sinusoidal modulation in an AM system. Assuming no overmodulation, the modulation index (μ) when the maximum and minimum values of the envelope, respectively, are 3 V and 1 V, is _____.

- Q.24 To maximize power transfer, a lossless transmission line is to be matched to a resistive load impedance via a $\lambda/4$ transformer as shown.



The characteristic impedance (in Ω) of the $\lambda/4$ transformer is _____.

- Q.25 Which one of the following field patterns represents a TEM wave travelling in the positive x direction?

- (A) $E = +8\hat{y}$, $H = -4\hat{z}$ (B) $E = -2\hat{y}$, $H = -3\hat{z}$
 (C) $E = +2\hat{z}$, $H = +2\hat{y}$ (D) $E = -3\hat{y}$, $H = +4\hat{z}$

Q. 26 – Q. 55 carry two marks each.

- Q.26 The system of linear equations

$$\begin{pmatrix} 2 & 1 & 3 \\ 3 & 0 & 1 \\ 1 & 2 & 5 \end{pmatrix} \begin{pmatrix} a \\ b \\ c \end{pmatrix} = \begin{pmatrix} 5 \\ -4 \\ 14 \end{pmatrix} \text{ has}$$

- (A) a unique solution
 (B) infinitely many solutions
 (C) no solution
 (D) exactly two solutions

- Q.27 The real part of an analytic function $f(z)$ where $z = x + jy$ is given by $e^{-y}\cos(x)$. The imaginary part of $f(z)$ is

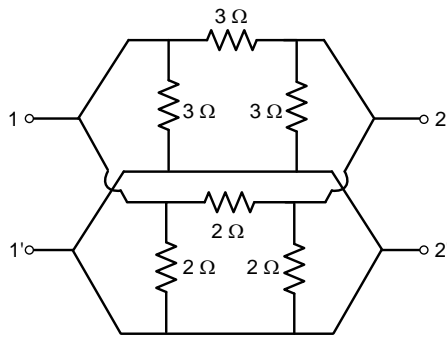
- (A) $e^y\cos(x)$ (B) $e^{-y}\sin(x)$ (C) $-e^y\sin(x)$ (D) $-e^{-y}\sin(x)$

- Q.28 The maximum value of the determinant among all 2×2 real symmetric matrices with trace 14 is _____.

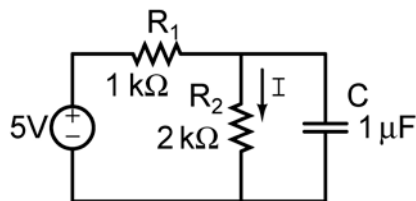
- Q.29 If $\vec{r} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$ and $|\vec{r}| = r$, then $\text{div}(r^2\nabla(\ln r)) =$ _____.

- Q.30 A series LCR circuit is operated at a frequency different from its resonant frequency. The operating frequency is such that the current leads the supply voltage. The magnitude of current is half the value at resonance. If the values of L, C and R are 1 H, 1 F and 1 Ω , respectively, the operating angular frequency (in rad/s) is _____.

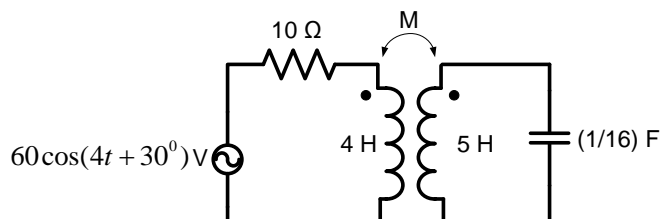
- Q.31 In the h-parameter model of the 2-port network given in the figure shown, the value of h_{22} (in S) is _____ .



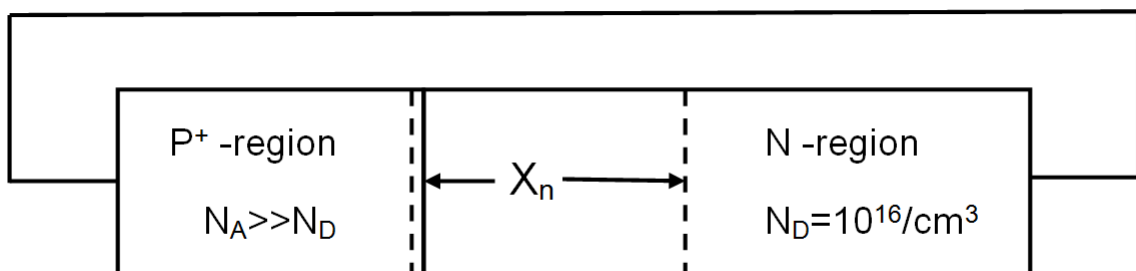
- Q.32 In the figure shown, the capacitor is initially uncharged. Which one of the following expressions describes the current $I(t)$ (in mA) for $t > 0$?



- (A) $I(t) = \frac{5}{3}(1 - e^{-t/\tau})$, $\tau = \frac{2}{3}$ msec
 (B) $I(t) = \frac{5}{2}(1 - e^{-t/\tau})$, $\tau = \frac{2}{3}$ msec
 (C) $I(t) = \frac{5}{3}(1 - e^{-t/\tau})$, $\tau = 3$ msec
 (D) $I(t) = \frac{5}{2}(1 - e^{-t/\tau})$, $\tau = 3$ msec
- Q.33 In the magnetically coupled circuit shown in the figure, 56 % of the total flux emanating from one coil links the other coil. The value of the mutual inductance (in H) is _____ .

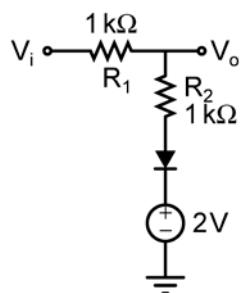


- Q.34 Assume electronic charge $q = 1.6 \times 10^{-19}$ C, $kT/q = 25$ mV and electron mobility $\mu_n = 1000$ cm²/V-s. If the concentration gradient of electrons injected into a P-type silicon sample is 1×10^{21} /cm⁴, the magnitude of electron diffusion current density (in A/cm²) is _____ .
- Q.35 Consider an abrupt PN junction (at $T = 300$ K) shown in the figure. The depletion region width X_n on the N-side of the junction is $0.2 \mu\text{m}$ and the permittivity of silicon (ϵ_{si}) is 1.044×10^{-12} F/cm. At the junction, the approximate value of the peak electric field (in kV/cm) is _____ .

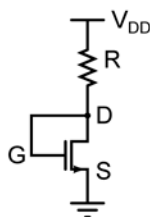


- Q.36 When a silicon diode having a doping concentration of $N_A = 9 \times 10^{16} \text{ cm}^{-3}$ on p-side and $N_D = 1 \times 10^{16} \text{ cm}^{-3}$ on n-side is reverse biased, the total depletion width is found to be $3 \mu\text{m}$. Given that the permittivity of silicon is $1.04 \times 10^{-12} \text{ F/cm}$, the depletion width on the p-side and the maximum electric field in the depletion region, respectively, are
- (A) $2.7 \mu\text{m}$ and $2.3 \times 10^5 \text{ V/cm}$
 (B) $0.3 \mu\text{m}$ and $4.15 \times 10^5 \text{ V/cm}$
 (C) $0.3 \mu\text{m}$ and $0.42 \times 10^5 \text{ V/cm}$
 (D) $2.1 \mu\text{m}$ and $0.42 \times 10^5 \text{ V/cm}$

- Q.37 The diode in the circuit shown has $V_{on} = 0.7 \text{ Volts}$ but is ideal otherwise. If $V_i = 5 \sin(\omega t) \text{ Volts}$, the minimum and maximum values of V_o (in Volts) are, respectively,



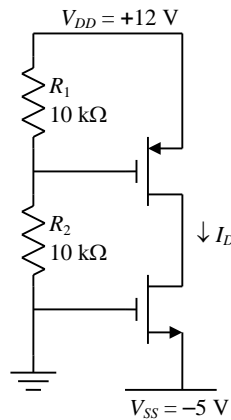
- (A) -5 and 2.7 (B) 2.7 and 5
 (C) -5 and 3.85 (D) 1.3 and 5
- Q.38 For the n-channel MOS transistor shown in the figure, the threshold voltage V_{Th} is 0.8 V . Neglect channel length modulation effects. When the drain voltage $V_D = 1.6 \text{ V}$, the drain current I_D was found to be 0.5 mA . If V_D is adjusted to be 2 V by changing the values of R and V_{DD} , the new value of I_D (in mA) is



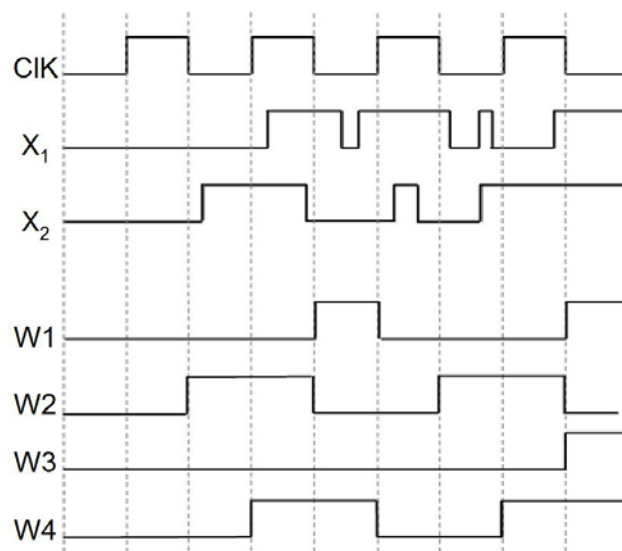
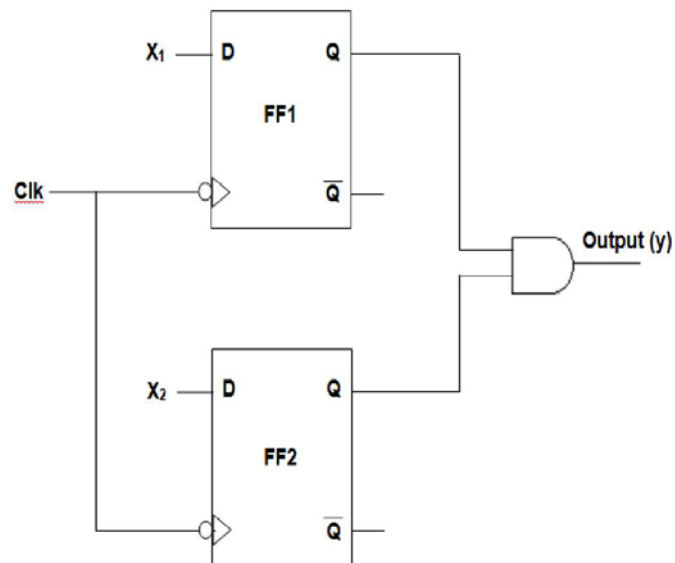
- (A) 0.625 (B) 0.75 (C) 1.125 (D) 1.5

Q.39 For the MOSFETs shown in the figure, the threshold voltage $|V_t| = 2$ V and

$$K = \frac{1}{2} \mu C_{ox} \left(\frac{W}{L} \right) = 0.1 \text{ mA/V}^2. \text{ The value of } I_D \text{ (in mA) is } \underline{\hspace{2cm}}.$$



Q.40 In the circuit shown, choose the correct timing diagram of the output (y) from the given waveforms W1, W2, W3 and W4.



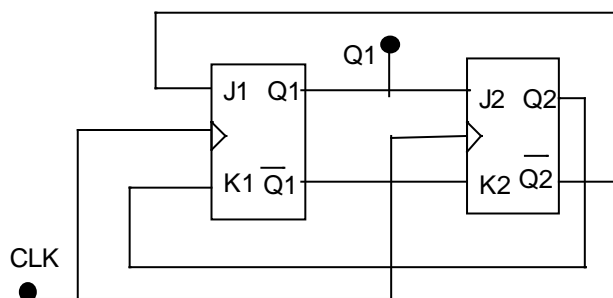
(A) W1

(B) W2

(C) W3

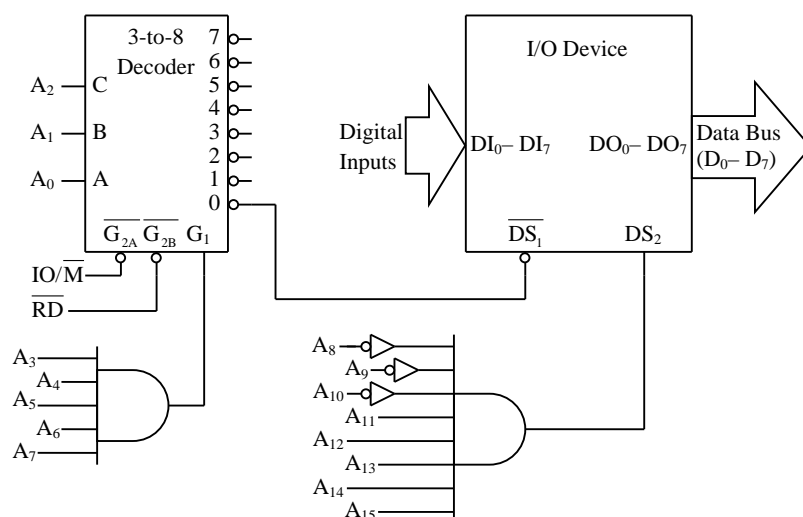
(D) W4

- Q.41 The outputs of the two flip-flops Q1, Q2 in the figure shown are initialized to 0, 0. The sequence generated at Q1 upon application of clock signal is



- (A) 01110...
(B) 01010...
(C) 00110...
(D) 01100...

- Q.42 For the 8085 microprocessor, the interfacing circuit to input 8-bit digital data ($DI_0 - DI_7$) from an external device is shown in the figure. The instruction for correct data transfer is



- (A) MVI A, F8H (B) IN F8H (C) OUT F8H (D) LDA F8F8H

- Q.43 Consider a discrete-time signal

$$x[n] = \begin{cases} n & \text{for } 0 \leq n \leq 10 \\ 0 & \text{otherwise} \end{cases}$$

If $y[n]$ is the convolution of $x[n]$ with itself, the value of $y[4]$ is _____.

- Q.44 The input-output relationship of a causal stable LTI system is given as

$$y[n] = \alpha y[n-1] + \beta x[n]$$

If the impulse response $h[n]$ of this system satisfies the condition $\sum_{n=0}^{\infty} h[n] = 2$, the relationship between α and β is

- (A) $\alpha = 1 - \beta/2$ (B) $\alpha = 1 + \beta/2$ (C) $\alpha = 2\beta$ (D) $\alpha = -2\beta$

Q.45 The value of the integral $\int_{-\infty}^{\infty} \text{sinc}^2(5t) dt$ is _____.

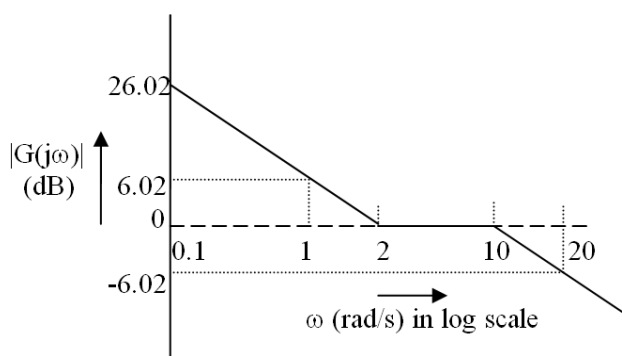
Q.46 An unforced linear time invariant (LTI) system is represented by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

If the initial conditions are $x_1(0) = 1$ and $x_2(0) = -1$, the solution of the state equation is

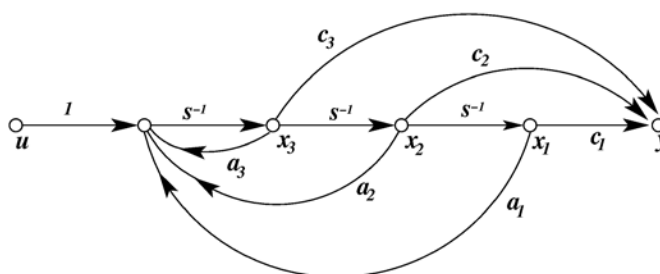
- (A) $x_1(t) = -1, x_2(t) = 2$
 (B) $x_1(t) = -e^{-t}, x_2(t) = 2e^{-t}$
 (C) $x_1(t) = e^{-t}, x_2(t) = -e^{-2t}$
 (D) $x_1(t) = -e^{-t}, x_2(t) = -2e^{-t}$

Q.47 The Bode asymptotic magnitude plot of a minimum phase system is shown in the figure.



If the system is connected in a unity negative feedback configuration, the steady state error of the closed loop system, to a unit ramp input, is _____.

Q.48 Consider the state space system expressed by the signal flow diagram shown in the figure.



The corresponding system is

- (A) always controllable
 (B) always observable
 (C) always stable
 (D) always unstable

Q.49 The input to a 1-bit quantizer is a random variable X with pdf $f_X(x) = 2e^{-2x}$ for $x \geq 0$ and $f_X(x) = 0$ for $x < 0$. For outputs to be of equal probability, the quantizer threshold should be _____.

Q.50 Coherent orthogonal binary FSK modulation is used to transmit two equiprobable symbol waveforms $s_1(t) = \alpha \cos 2\pi f_1 t$ and $s_2(t) = \alpha \cos 2\pi f_2 t$, where $\alpha = 4$ mV. Assume an AWGN channel with two-sided noise power spectral density $\frac{N_0}{2} = 0.5 \times 10^{-12}$ W/Hz. Using an optimal receiver and the relation $Q(v) = \frac{1}{\sqrt{2\pi}} \int_v^\infty e^{-u^2/2} du$, the bit error probability for a data rate of 500 kbps is

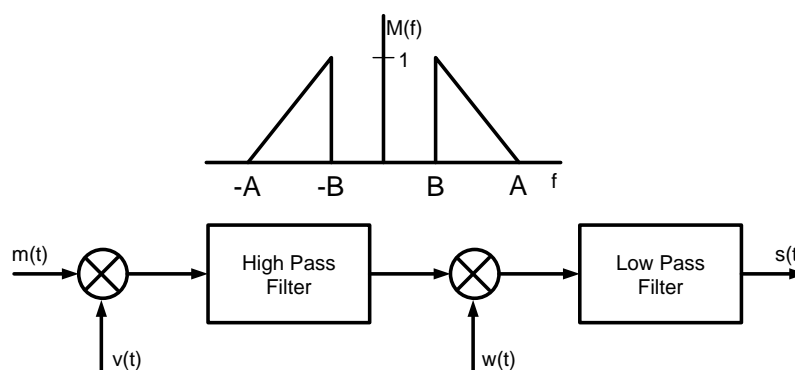
- (A) $Q(2)$ (B) $Q(2\sqrt{2})$ (C) $Q(4)$ (D) $Q(4\sqrt{2})$

Q.51 The power spectral density of a real stationary random process $X(t)$ is given by

$$S_X(f) = \begin{cases} \frac{1}{W}, & |f| \leq W \\ 0, & |f| > W \end{cases}$$

The value of the expectation $E \left[\pi X(t) X \left(t - \frac{1}{4W} \right) \right]$ is _____.

Q.52 In the figure, $M(f)$ is the Fourier transform of the message signal $m(t)$ where $A = 100$ Hz and $B = 40$ Hz. Given $v(t) = \cos(2\pi f_c t)$ and $w(t) = \cos(2\pi(f_c + A)t)$, where $f_c > A$. The cutoff frequencies of both the filters are f_c .



The bandwidth of the signal at the output of the modulator (in Hz) is _____.

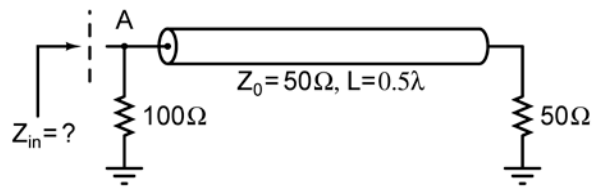
Q.53 If the electric field of a plane wave is

$$\vec{E}(z, t) = \hat{x}3\cos(\omega t - kz + 30^\circ) - \hat{y}4\sin(\omega t - kz + 45^\circ) \text{ (mV/m)},$$

the polarization state of the plane wave is

- (A) left elliptical
(B) left circular
(C) right elliptical
(D) right circular

- Q.54 In the transmission line shown, the impedance Z_{in} (in ohms) between node A and the ground is _____.



- Q.55 For a rectangular waveguide of internal dimensions $a \times b$ ($a > b$), the cut-off frequency for the TE_{11} mode is the arithmetic mean of the cut-off frequencies for TE_{10} mode and TE_{20} mode. If $a = \sqrt{5}$ cm, the value of b (in cm) is _____.

END OF THE QUESTION PAPER