SESSION - 1

MANORANJAN KUMAR
gateestudy.com
YouTube: @Manoranjan_Kr
WhatsApp: GATE EE | Electrical Engineering

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.

MANORANJAN KUMAR
gateestudy.com
YouTube: @Manoranjan_Kr
WhatsApp: GATE EE | Electrical Engineering

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.*

<u>Navigating to a Question :</u>

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.

MANORANJAN KUMAR
gateestudy.com
YouTube: @Manoranjan_Kr
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GATE 2014 Examination

EE: Electrical 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 Which of the following options is the closest in meaning to the phrase underlined in the sentence below?

It is fascinating to see life forms cope with varied environmental conditions.

(A) adopt to (B) adapt to (C) adept in (D) accept with

Q.2 Choose the most appropriate word from the options given below to complete the following sentence.

He could not understand the judges awarding her the first prize, because he thought that her performance was quite _____.

(A) superb (B) medium (C) mediocre (D) exhilarating

Q.3 In a press meet on the recent scam, the minister said, "The buck stops here". What did the minister convey by the statement?

(A) He wants all the money
(B) He will return the money
(C) He will assume final responsibility
(D) He will resist all enquiries

Q.4 If $(z + 1/z)^2 = 98$, compute $(z^2 + 1/z^2)$.

Q.5 The roots of $ax^2 + bx + c = 0$ are real and positive. a, b and c are real. Then $ax^2 + b|x| + c = 0$ has

(A) no roots
(B) 2 real roots
(C) 3 real roots
(D) 4 real roots

Q. 6 – Q. 10 carry two marks each.

Q.6 The Palghat Gap (or Palakkad Gap), a region about 30 km wide in the southern part of the Western Ghats in India, is lower than the hilly terrain to its north and south. The exact reasons for the formation of this gap are not clear. It results in the neighbouring regions of Tamil Nadu getting more rainfall from the South West monsoon and the neighbouring regions of Kerala having higher summer temperatures.

What can be inferred from this passage?

(A) The Palghat gap is caused by high rainfall and high temperatures in southern Tamil Nadu and Kerala
(B) The regions in Tamil Nadu and Kerala that are near the Palghat Gap are low-lying
(C) The low terrain of the Palghat Gap has a significant impact on weather patterns in neighbouring parts of Tamil Nadu and Kerala
(D) Higher summer temperatures result in higher rainfall near the Palghat Gap area

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GA 7 (GATE 2014)

Q.7 Geneticists say that they are very close to confirming the genetic roots of psychiatric illnesses such as depression and schizophrenia, and consequently, that doctors will be able to eradicate these diseases through early identification and gene therapy.

On which of the following assumptions does the statement above rely?

(A) Strategies are now available for eliminating psychiatric illnesses
(B) Certain psychiatric illnesses have a genetic basis
(C) All human diseases can be traced back to genes and how they are expressed
(D) In the future, genetics will become the only relevant field for identifying psychiatric illnesses

Q.8 Round-trip tickets to a tourist destination are eligible for a discount of 10% on the total fare. In addition, groups of 4 or more get a discount of 5% on the total fare. If the one way single person fare is Rs 100, a group of 5 tourists purchasing round-trip tickets will be charged Rs _____.

Q.9 In a survey, 300 respondents were asked whether they own a vehicle or not. If yes, they were further asked to mention whether they own a car or scooter or both. Their responses are tabulated below. What percent of respondents do not own a scooter?

		Men	Women
Own vehicle	Car	40	34
	Scooter	30	20
	Both	60	46
Do not own vehicle		20	50

Q.10 When a point inside of a tetrahedron (a solid with four triangular surfaces) is connected by straight lines to its corners, how many (new) internal planes are created with these lines? _____

END OF THE QUESTION PAPER

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Q. 1 – Q. 25 carry one mark each.

Q.1 Given a system of equations:

$$x + 2y + 2z = b_1$$
$$5x + y + 3z = b_2$$

Which of the following is true regarding its solutions

(A) The system has a unique solution for any given b_1 and b_2
(B) The system will have infinitely many solutions for any given b_1 and b_2
(C) Whether or not a solution exists depends on the given b_1 and b_2
(D) The system would have no solution for any values of b_1 and b_2

Q.2 Let $f(x) = x\,e^{-x}$. The maximum value of the function in the interval (0, ∞) is

(A) e^{-1} (B) e (C) $1 - e^{-1}$ (D) $1 + e^{-1}$

Q.3 The solution for the differential equation

$$\frac{d^2x}{dt^2} = -9\,x,$$

with initial conditions $x(0) = 1$ and $\frac{dx}{dt}\Big|_{t=0} = 1$, is

(A) $t^2 + t + 1$
(B) $\sin 3t + \frac{1}{3}\cos 3t + \frac{2}{3}$
(C) $\frac{1}{3}\sin 3t + \cos 3t$
(D) $\cos 3t + t$

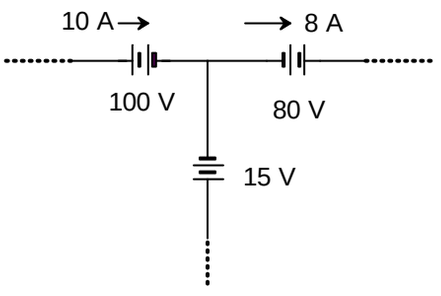
Q.4 Let $X(s) = \frac{3s+5}{s^2+10s+21}$ be the Laplace Transform of a signal $x(t)$. Then, $x(0^+)$ is

(A) 0 (B) 3 (C) 5 (D) 21

Q.5 Let S be the set of points in the complex plane corresponding to the unit circle. (That is, $S = \{z : |z| = 1\}$). Consider the function $f(z) = z\,z^*$ where z^* denotes the complex conjugate of z. The $f(z)$ maps S to which one of the following in the complex plane

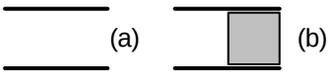
(A) unit circle
(B) horizontal axis line segment from origin to (1, 0)
(C) the point (1, 0)
(D) the entire horizontal axis

Q.6 The three circuit elements shown in the figure are part of an electric circuit. The total power absorbed by the three circuit elements in watts is _____.



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Q.7 C_0 is the capacitance of a parallel plate capacitor with air as dielectric (as in figure (a)). If, half of the entire gap as shown in figure (b) is filled with a dielectric of permittivity ϵ_r , the expression for the modified capacitance is



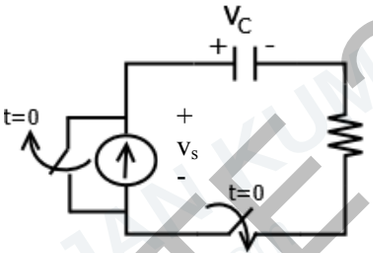
(A) $\frac{C_0}{2}(1 + \epsilon_r)$

(B) $(C_0 + \epsilon_r)$

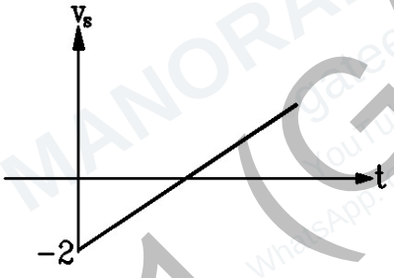
(C) $\frac{C_0}{2}\epsilon_r$

(D) $C_0(1 + \epsilon_r)$

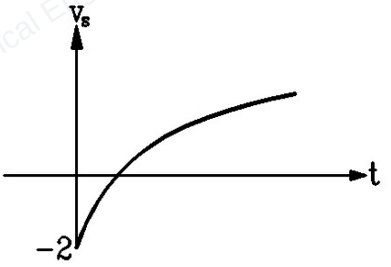
Q.8 A combination of 1 μF capacitor with an initial voltage $v_c(0) = -2$ V in series with a 100 Ω resistor is connected to a 20 mA ideal dc current source by operating both switches at $t = 0$ s as shown. Which of the following graphs shown in the options approximates the voltage v_s across the current source over the next few seconds?



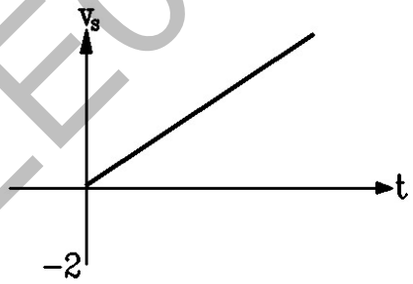
(A)



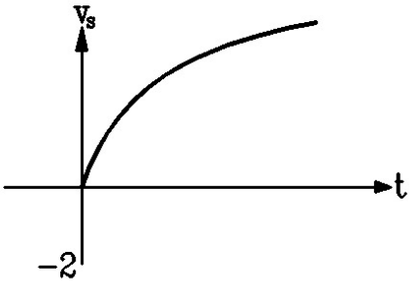
(B)



(C)



(D)



Q.9 $x(t)$ is nonzero only for $T_x < t < T'_x$, and similarly, $y(t)$ is nonzero only for $T_y < t < T'_y$. Let $z(t)$ be convolution of $x(t)$ and $y(t)$. Which one of the following statements is TRUE?

(A) $z(t)$ can be nonzero over an unbounded interval.
(B) $z(t)$ is nonzero for $t < T_x + T_y$.
(C) $z(t)$ is zero outside of $T_x + T_y < t < T'_x + T'_y$.
(D) $z(t)$ is nonzero for $t > T'_x + T'_y$.

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MANORANJAN KUMAR
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YouTube: @Manoranjan_Kr
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Q.10 For a periodic square wave, which one of the following statements is TRUE?

(A) The Fourier series coefficients do not exist.
(B) The Fourier series coefficients exist but the reconstruction converges at no point.
(C) The Fourier series coefficients exist and the reconstruction converges at most points.
(D) The Fourier series coefficients exist and the reconstruction converges at every point.

Q.11 An 8-pole, 3-phase, 50 Hz induction motor is operating at a speed of 700 rpm. The frequency of the rotor current of the motor in Hz is _____.

Q.12 For a specified input voltage and frequency, if the equivalent radius of the core of a transformer is reduced by half, the factor by which the number of turns in the primary should change to maintain the same no load current is

(A) 1/4 (B) 1/2 (C) 2 (D) 4

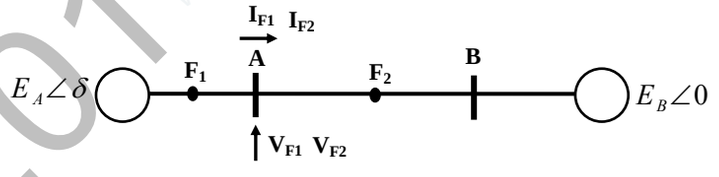
Q.13 A star connected 400 V, 50 Hz, 4 pole synchronous machine gave the following open circuit and short circuit test results:
Open circuit test: V_{oc} = 400 V (rms, line-to-line) at field current, I_f = 2.3 A
Short circuit test: I_{sc} = 10 A (rms, phase) at field current, I_f = 1.5 A

The value of per phase synchronous impedance in Ω at rated voltage is _____.

Q.14 The undesirable property of an electrical insulating material is

(A) high dielectric strength (B) high relative permittivity
(C) high thermal conductivity (D) high insulation resistivity

Q.15 Three-phase to ground fault takes place at locations F_1 and F_2 in the system shown in the figure

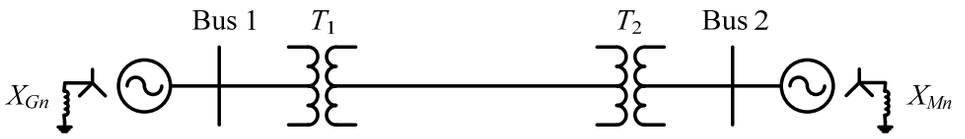


If the fault takes place at location F_1, then the voltage and the current at bus A are V_{F1} and I_{F1} respectively. If the fault takes place at location F_2, then the voltage and the current at bus A are V_{F2} and I_{F2} respectively. The correct statement about voltages and currents during faults at F_1 and F_2 is

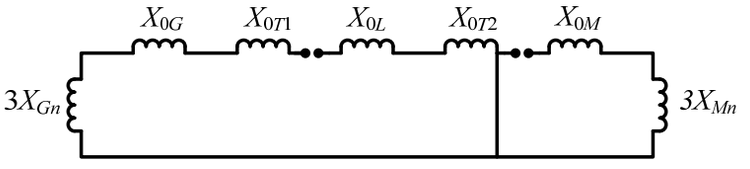
(A) V_{F1} leads I_{F1} and V_{F2} leads I_{F2}
(B) V_{F1} leads I_{F1} and V_{F2} lags I_{F2}
(C) V_{F1} lags I_{F1} and V_{F2} leads I_{F2}
(D) V_{F1} lags I_{F1} and V_{F2} lags I_{F2}

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Q.16 A 2-bus system and corresponding zero sequence network are shown in the figure.



(a)



(b)

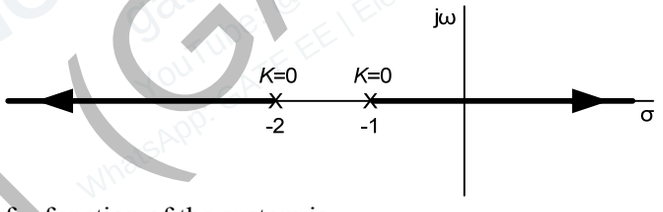
The transformers T_1 and T_2 are connected as

(A) ⅄ ⅄ and ⅄ Δ
(B) ⅄ ⅄ and ⅄ Δ
(C) ⅄ Δ and Δ ⅄
(D) Δ ⅄ and ⅄ ⅄

Q.17 In the formation of Routh-Hurwitz array for a polynomial, all the elements of a row have zero values. This premature termination of the array indicates the presence of

(A) only one root at the origin
(B) imaginary roots
(C) only positive real roots
(D) only negative real roots

Q.18 The root locus of a unity feedback system is shown in the figure



The closed loop transfer function of the system is

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

Q.19 Power consumed by a balanced 3-phase, 3-wire load is measured by the two wattmeter method. The first wattmeter reads twice that of the second. Then the load impedance angle in radians is

(A) π/12 (B) π/8 (C) π/6 (D) π/3

Q.20 In an oscilloscope screen, linear sweep is applied at the

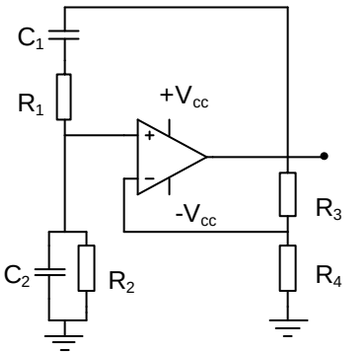
(A) vertical axis
(B) horizontal axis
(C) origin
(D) both horizontal and vertical axis

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11/65

Q.21 A cascade of three identical modulo-5 counters has an overall modulus of

(A) 5 (B) 25 (C) 125 (D) 625

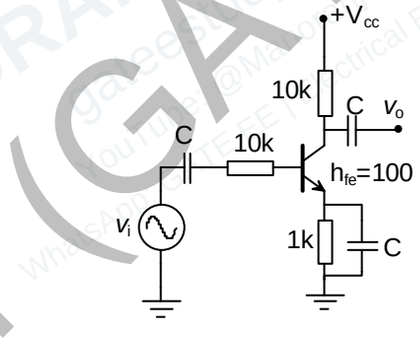
Q.22 In the Wien Bridge oscillator circuit shown in figure, the bridge is balanced when



(A) $\frac{R_3}{R_4}=\frac{R_1}{R_2}$, $\omega=\frac{1}{\sqrt{R_1C_1R_2C_2}}$ (B) $\frac{R_2}{R_1}=\frac{C_2}{C_1}$, $\omega=\frac{1}{R_1C_1R_2C_2}$

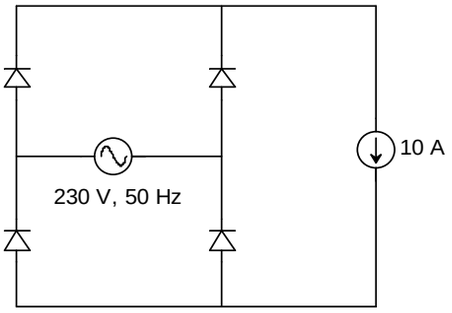
(C) $\frac{R_3}{R_4}=\frac{R_1}{R_2}+\frac{C_2}{C_1}$, $\omega=\frac{1}{\sqrt{R_1C_1R_2C_2}}$ (D) $\frac{R_3}{R_4}+\frac{R_1}{R_2}=\frac{C_2}{C_1}$, $\omega=\frac{1}{R_1C_1R_2C_2}$

Q.23 The magnitude of the mid-band voltage gain of the circuit shown in figure is (assuming h_{fe} of the transistor to be 100)



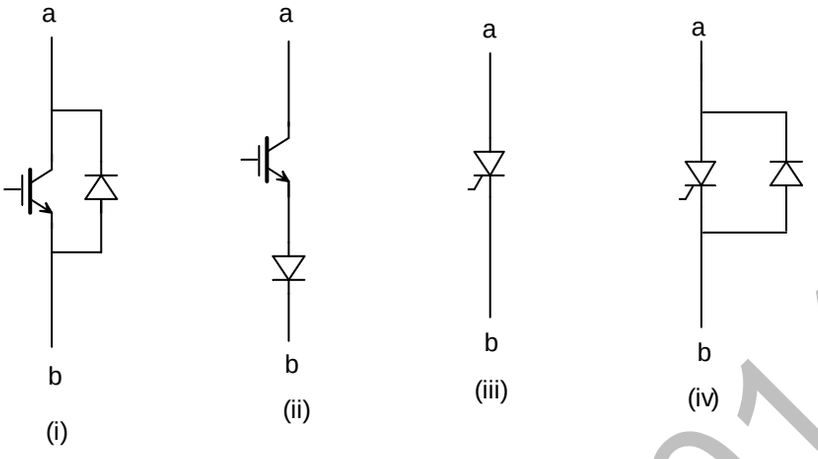
(A) 1 (B) 10 (C) 20 (D) 100

Q.24 The figure shows the circuit of a rectifier fed from a 230-V (rms), 50-Hz sinusoidal voltage source. If we want to replace the current source with a resistor so that the rms value of the current supplied by the voltage source remains unchanged, the value of the resistance (in ohms) is _____ (Assume diodes to be ideal.)



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Q.25 Figure shows four electronic switches (i), (ii), (iii) and (iv). Which of the switches can block voltages of either polarity (applied between terminals 'a' and 'b') when the active device is in the OFF state?



(A) (i), (ii) and (iii)
(B) (ii), (iii) and (iv)
(C) (ii) and (iii)
(D) (i) and (iv)

Q. 26 – Q. 55 carry two marks each.

Q.26 Let $g:[0,\infty) \longrightarrow [0,\infty)$ be a function defined by $g(x) = x - [x]$, where $[x]$ represents the integer part of x. (That is, it is the largest integer which is less than or equal to x).
The value of the constant term in the Fourier series expansion of $g(x)$ is _____

Q.27 A fair coin is tossed *n* times. The probability that the difference between the number of heads and tails is (*n*-3) is

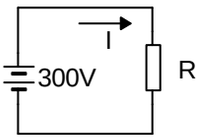
(A) 2^{-n} (B) 0 (C) ${}^{n}C_{n-3}2^{-n}$ (D) 2^{-n+3}

Q.28 The line integral of function **F** = *yz***i,** in the counterclockwise direction, along the circle $x^2+y^2 = 1$ at $z = 1$ is

(A) -2π (B) -π (C) π (D) 2π

Q.29 An incandescent lamp is marked 40 W, 240V. If resistance at room temperature (26°C) is 120 Ω, and temperature coefficient of resistance is $4.5\text{x}10^{-3}$/°C, then its 'ON' state filament temperature in °C is approximately _____

Q.30 In the figure, the value of resistor R is (25 + I/2) ohms, where I is the current in amperes. The current I is _____



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Q.31 In an unbalanced three phase system, phase current $I_a = 1\angle(-90^o)$ pu, negative sequence current $I_{b2} = 4\angle(-150^o)$ pu, zero sequence current $I_{c0} = 3\angle 90^o$ pu. The magnitude of phase current I_b in pu is

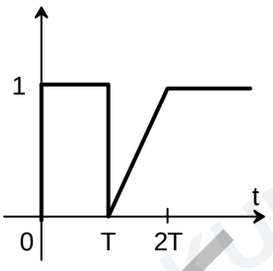
(A) 1.00 (B) 7.81 (C) 11.53 (D) 13.00

Q.32 The following four vector fields are given in Cartesian co-ordinate system. The vector field which does not satisfy the property of magnetic flux density is

(A) $y^2\mathbf{a}_x + z^2\mathbf{a}_y + x^2\mathbf{a}_z$ (B) $z^2\mathbf{a}_x + x^2\mathbf{a}_y + y^2\mathbf{a}_z$

(C) $x^2\mathbf{a}_x + y^2\mathbf{a}_y + z^2\mathbf{a}_z$ (D) $y^2z^2\mathbf{a}_x + x^2z^2\mathbf{a}_y + x^2y^2\mathbf{a}_z$

Q.33 The function shown in the figure can be represented as



(A) $u(t) - u(t-T) + \frac{(t-T)}{T}u(t-T) - \frac{(t-2T)}{T}u(t-2T)$

(B) $u(t) + \frac{t}{T}u(t-T) - \frac{t}{T}u(t-2T)$

(C) $u(t) - u(t-T) + \frac{(t-T)}{T}u(t) - \frac{(t-2T)}{T}u(t)$

(D) $u(t) + \frac{(t-T)}{T}u(t-T) - 2\frac{(t-2T)}{T}u(t-2T)$

Q.34 Let $X(z) = \frac{1}{1-z^{-3}}$ be the Z-transform of a causal signal $x[n]$. Then, the values of $x[2]$ and $x[3]$ are

(A) 0 and 0 (B) 0 and 1 (C) 1 and 0 (D) 1 and 1

Q.35 Let $f(t)$ be a continuous time signal and let $F(\omega)$ be its Fourier Transform defined by

$$F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}\,dt$$

Define $g(t)$ by

$$g(t) = \int_{-\infty}^{\infty} F(u)\,e^{-jut}\,du$$

What is the relationship between $f(t)$ and $g(t)$?

(A) $g(t)$ would always be proportional to $f(t)$.
(B) $g(t)$ would be proportional to $f(t)$ if $f(t)$ is an even function.
(C) $g(t)$ would be proportional to $f(t)$ only if $f(t)$ is a sinusoidal function.
(D) $g(t)$ would never be proportional to $f(t)$.

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Q.36 The core loss of a single phase, 230/115 V, 50 Hz power transformer is measured from 230 V side by feeding the primary (230 V side) from a variable voltage variable frequency source while keeping the secondary open circuited. The core loss is measured to be 1050 W for 230 V, 50 Hz input. The core loss is again measured to be 500 W for 138 V, 30 Hz input. The hysteresis and eddy current losses of the transformer for 230 V, 50 Hz input are respectively,

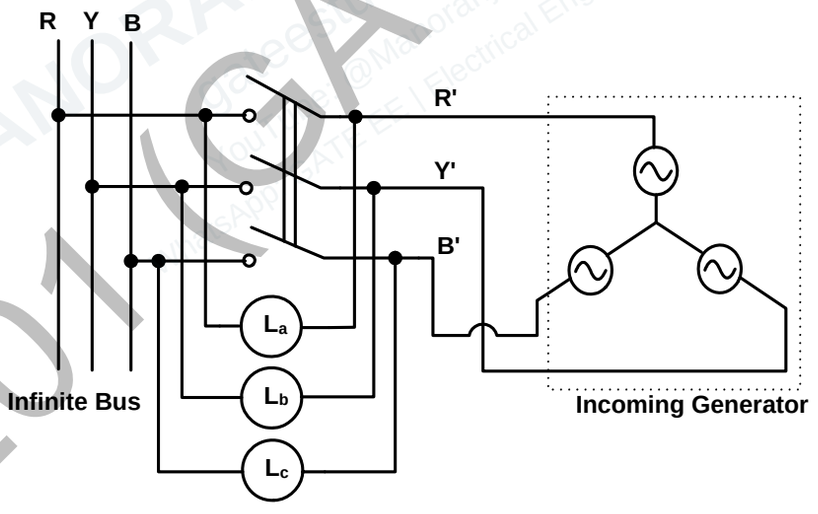
(A) 508 W and 542 W.
(B) 468 W and 582 W.
(C) 498 W and 552 W.
(D) 488 W and 562 W.

Q.37 A 15 kW, 230 V dc shunt motor has armature circuit resistance of 0.4 Ω and field circuit resistance of 230 Ω. At no load and rated voltage, the motor runs at 1400 rpm and the line current drawn by the motor is 5 A. At full load, the motor draws a line current of 70 A. Neglect armature reaction. The full load speed of the motor in rpm is _____.

Q.38 A 3 phase, 50 Hz, six pole induction motor has a rotor resistance of 0.1 Ω and reactance of 0.92 Ω. Neglect the voltage drop in stator and assume that the rotor resistance is constant. Given that the full load slip is 3%, the ratio of maximum torque to full load torque is

(A) 1.567 (B) 1.712 (C) 1.948 (D) 2.134

Q.39 A three phase synchronous generator is to be connected to the infinite bus. The lamps are connected as shown in the figure for the synchronization. The phase sequence of bus voltage is R-Y-B and that of incoming generator voltage is R′-Y′-B′.



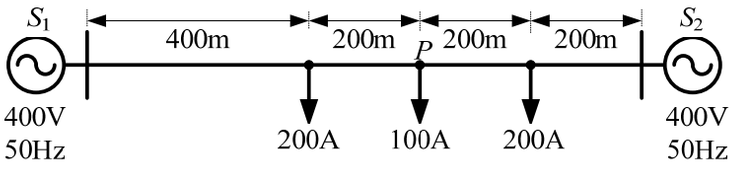
It was found that the lamps are becoming dark in the sequence L_a-L_b-L_c. It means that the phase sequence of incoming generator is

(A) opposite to infinite bus and its frequency is more than infinite bus
(B) opposite to infinite bus but its frequency is less than infinite bus
(C) same as infinite bus and its frequency is more than infinite bus
(D) same as infinite bus and its frequency is less than infinite bus

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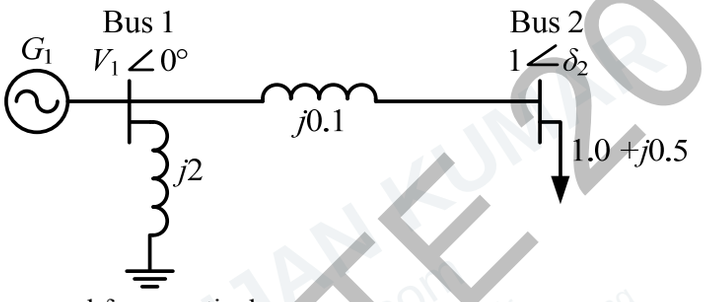
Q.40 A distribution feeder of 1 km length having resistance, but negligible reactance, is fed from both the ends by 400V, 50 Hz balanced sources. Both voltage sources S_1 and S_2 are in phase. The feeder supplies concentrated loads of unity power factor as shown in the figure.



The contributions of S_1 and S_2 in 100 A current supplied at location P respectively, are

(A) 75 A and 25 A (B) 50 A and 50 A (C) 25 A and 75 A (D) 0 A and 100 A

Q.41 A two bus power system shown in the figure supplies load of 1.0+j0.5 p.u.



The values of V_1 in p.u. and δ_2 respectively are

(A) 0.95 and 6.00° (B) 1.05 and -5.44° (C) 1.1 and -6.00° (D) 1.1 and -27.12°

Q.42 The fuel cost functions of two power plants are

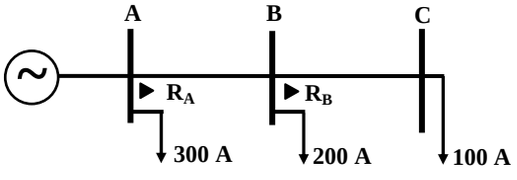
$$\text{Plant } P_1: \quad C_1 = 0.05Pg_1^2 + APg_1 + B$$

$$\text{Plant } P_2: \quad C_2 = 0.10Pg_2^2 + 3APg_2 + 2B$$

where, P_{g1} and P_{g2} are the generated powers of two plants, and A and B are the constants. If the two plants optimally share 1000 MW load at incremental fuel cost of 100 Rs/MWh, the ratio of load shared by plants P_1 and P_2 is

(A) 1:4 (B) 2:3 (C) 3:2 (D) 4:1

Q.43 The overcurrent relays for the line protection and loads connected at the buses are shown in the figure.



The relays are IDMT in nature having the characteristic

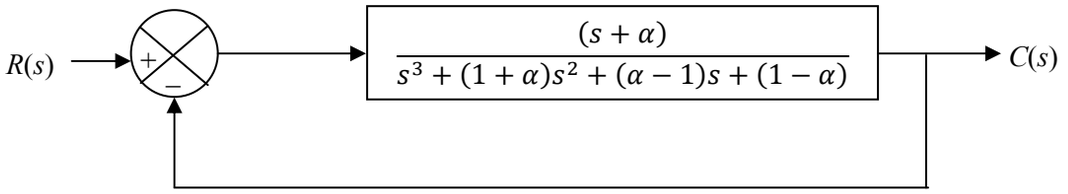
$$t_{op} = \frac{0.14 \times \text{Time Multiplier Setting}}{(\text{Plug Setting Multiplier})^{0.02} - 1}$$

The maximum and minimum fault currents at bus B are 2000 A and 500 A respectively. Assuming the time multiplier setting and plug setting for relay R_B to be 0.1 and 5A respectively, the operating time of R_B (in seconds) is _____

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@Manoranjan_Kr
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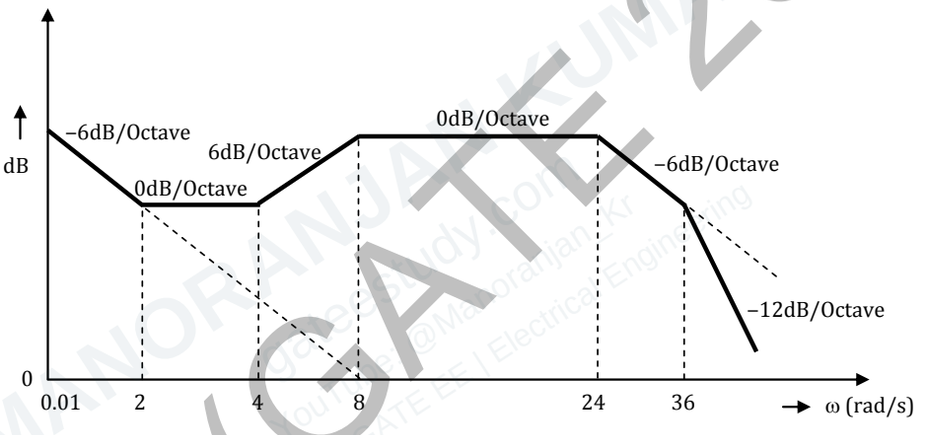
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Q.44 For the given system, it is desired that the system be stable. The minimum value of α for this condition is _____.



Q.45 The Bode magnitude plot of the transfer function $G(s) = \frac{K(1+0.5s)(1+as)}{s\left(1+\frac{s}{8}\right)(1+bs)\left(1+\frac{s}{36}\right)}$ is shown below:

Note that –6 dB/octave = –20 dB/decade. The value of $\frac{a}{bK}$ is _____.



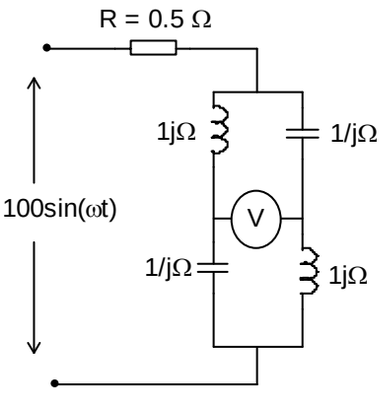
Q.46 A system matrix is given as follows.

$$A = \begin{bmatrix} 0 & 1 & -1 \\ -6 & -11 & 6 \\ -6 & -11 & 5 \end{bmatrix}.$$

The absolute value of the ratio of the maximum eigenvalue to the minimum eigenvalue is _____

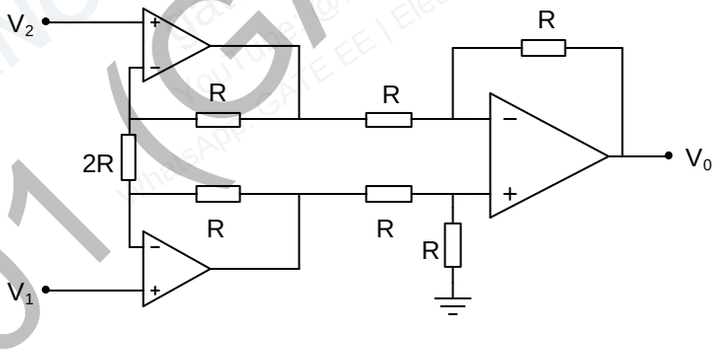
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Q.47 The reading of the voltmeter (rms) in volts, for the circuit shown in the figure is _____



Q.48 The dc current flowing in a circuit is measured by two ammeters, one PMMC and another electrodynamometer type, connected in series. The PMMC meter contains 100 turns in the coil, the flux density in the air gap is 0.2 Wb/m^2, and the area of the coil is 80 mm^2. The electrodynamometer ammeter has a change in mutual inductance with respect to deflection of 0.5 mH/deg. The spring constants of both the meters are equal. The value of current, at which the deflections of the two meters are same, is _____

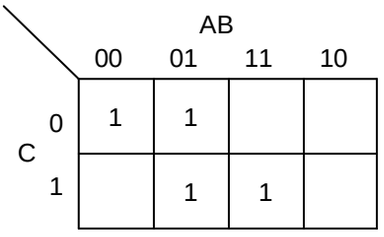
Q.49 Given that the op-amps in the figure are ideal, the output voltage V_0 is



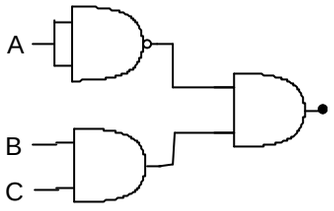
(A) $(V_1 - V_2)$
(B) $2\,(V_1 - V_2)$
(C) $(V_1 - V_2)/2$
(D) $(V_1 + V_2)$

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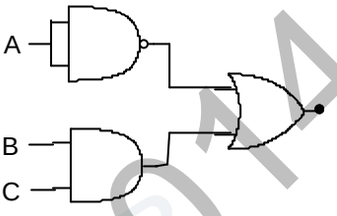
Q.50 Which of the following logic circuits is a realization of the function F whose Karnaugh map is shown in figure



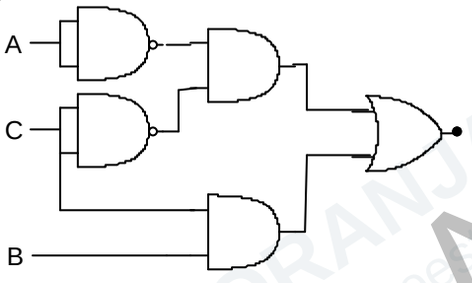
(A)



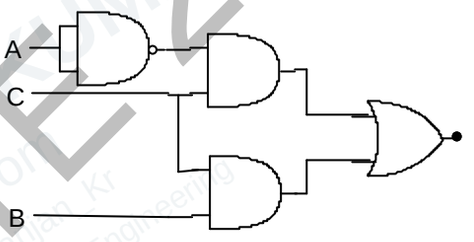
(B)



(C)

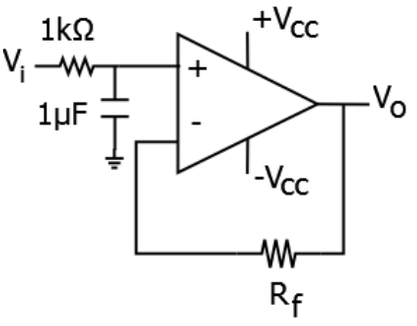


(D)

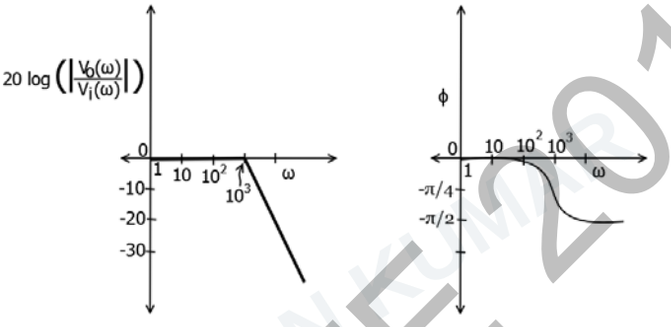


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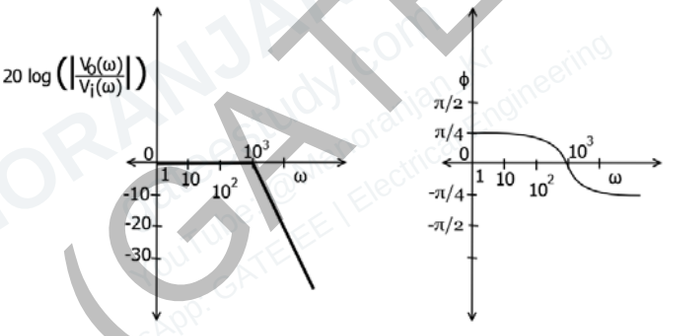
Q.51 In the figure shown, assume the op-amp to be ideal. Which of the alternatives gives the correct Bode plots for the transfer function $\frac{V_o(\omega)}{V_i(\omega)}$?



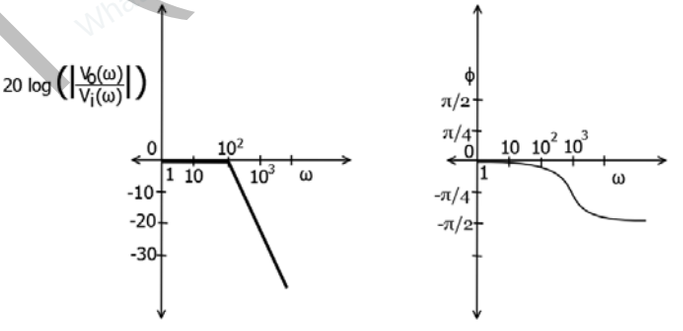
(A)



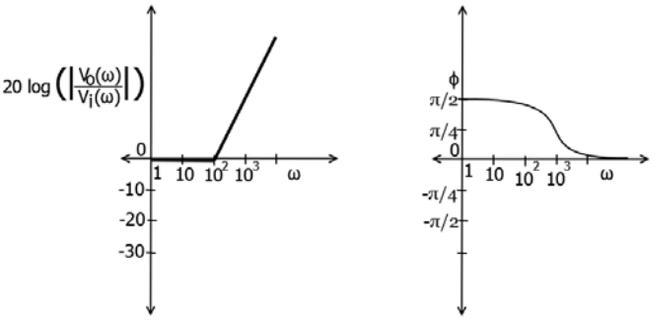
(B)



(C)

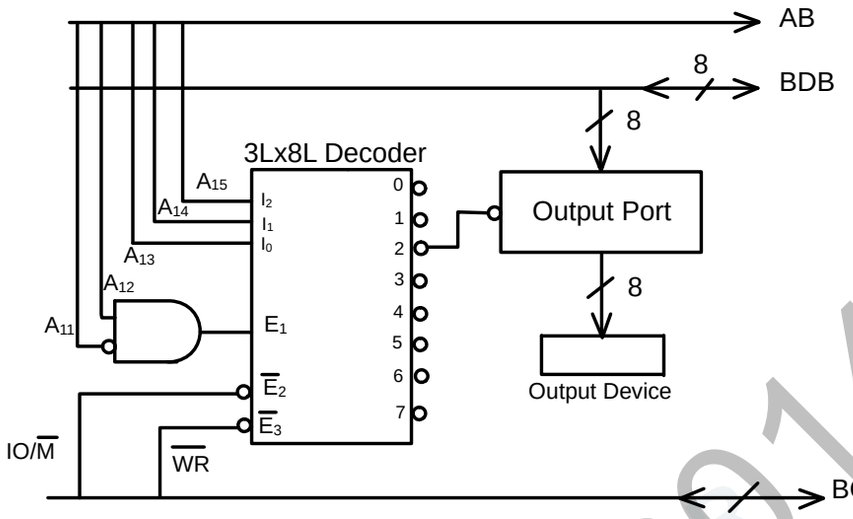


(D)



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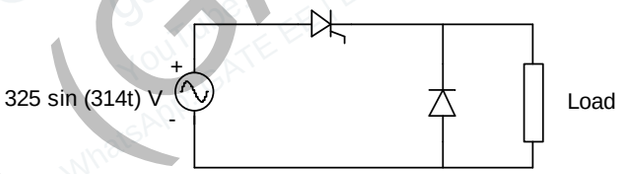
Q.52 An output device is interfaced with 8-bit microprocessor 8085A. The interfacing circuit is shown in figure



The interfacing circuit makes use of 3 Line to 8 Line decoder having 3 enable lines $E_1, \overline{E}_2, \overline{E}_3$. The address of the device is

(A) 50_H (B) 5000_H (C) $A0_H$ (D) $A000_H$

Q.53 The figure shows the circuit diagram of a rectifier. The load consists of a resistance 10 Ω and an inductance 0.05 H connected in series. Assuming ideal thyristor and ideal diode, the thyristor firing angle (in degree) needed to obtain an average load voltage of 70 V is _____



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Q.54 Figure (i) shows the circuit diagram of a chopper. The switch S in the circuit in figure (i) is switched such that the voltage v_D across the diode has the wave shape as shown in figure (ii). The capacitance *C* is large so that the voltage across it is constant. If switch S and the diode are ideal, the peak to peak ripple (in A) in the inductor current is _____

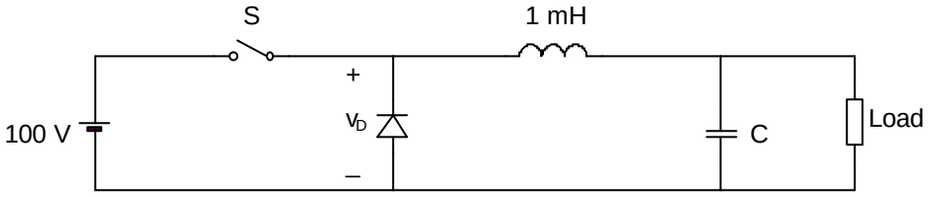


Figure (i)

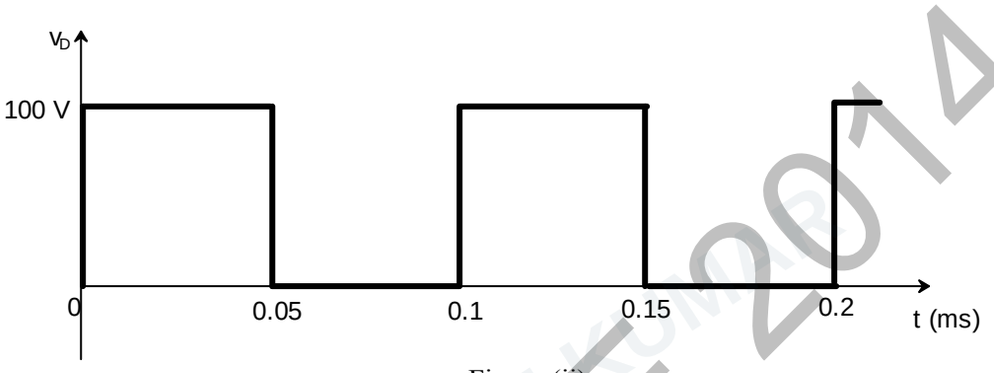
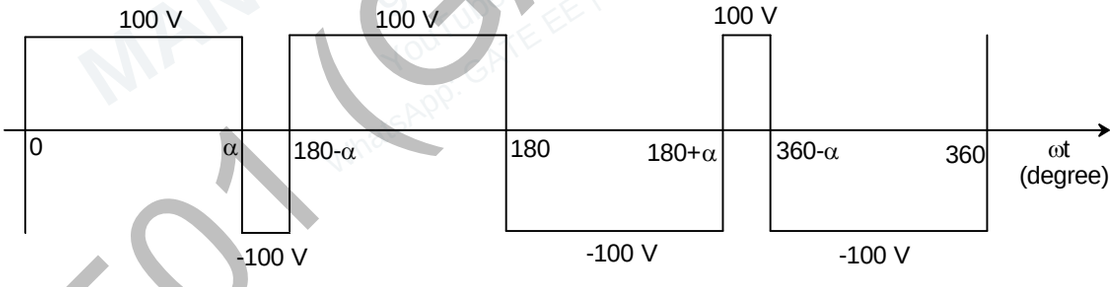


Figure (ii)

Q.55 The figure shows one period of the output voltage of an inverter. α should be chosen such that $60^o < \alpha < 90^o$. If rms value of the fundamental component is 50 V, then α in degree is_____



END OF THE QUESTION PAPER

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Answer Keys for EE - Electrical Engineering

Section	Q. No.	SECTION - M	
		Key / Range	Marks
GA	1	B	1
GA	2	C	1
GA	3	C	1
GA	4	96 to 96	1
GA	5	D	1
GA	6	C	2
GA	7	B	2
GA	8	850 to 850	2
GA	9	48 to 48	2
GA	10	6 to 6	2
EE	1	B	1
EE	2	A	1
EE	3	C	1
EE	4	B	1
EE	5	C	1
EE	6	330 to 330	1
EE	7	A	1
EE	8	C	1
EE	9	C	1
EE	10	C	1
EE	11	3.2 to 3.5	1
EE	12	C	1
EE	13	14.5 to 15.5	1
EE	14	B	1
EE	15	C	1
EE	16	B	1
EE	17	B	1
EE	18	C	1
EE	19	C	1
EE	20	B	1
EE	21	C	1
EE	22	C	1
EE	23	D	1

Section	Q. No.	SECTION - M	
		Key / Range	Marks
EE	24	23 to 23	1
EE	25	C	1
EE	26	0.5 to 0.5	2
EE	27	B	2
EE	28	B	2
EE	29	2470 to 2471	2
EE	30	10 to 10	2
EE	31	C	2
EE	32	C	2
EE	33	A	2
EE	34	B	2
EE	35	B	2
EE	36	A	2
EE	37	1239 to 1242	2
EE	38	C	2
EE	39	A	2
EE	40	D	2
EE	41	B	2
EE	42	D	2
EE	43	0.21 to 0.23	2
EE	44	0.61 to 0.63	2
EE	45	0.7 to 0.8	2
EE	46	2.9 to 3.1	2
EE	47	140 to 142	2
EE	48	3.0 to 3.4	2
EE	49	B	2
EE	50	C	2
EE	51	A	2
EE	52	B	2
EE	53	69 to 70	2
EE	54	2.49 to 2.51	2
EE	55	76.5 to 78.0	2

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gateestudy.com
YouTube: @Manoranjan_Kr
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SESSION - 2

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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.

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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.*

<u>Navigating to a Question :</u>

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.

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GATE 2014 Examination

EE: Electrical 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.

India is a post-colonial country because

(A) it was a former British colony
(B) Indian Information Technology professionals have colonized the world
(C) India does not follow any colonial practices
(D) India has helped other countries gain freedom

Q.2 Who _____ was coming to see us this evening?

(A) you said (B) did you say
(C) did you say that (D) had you said

Q.3 Match the columns.

Column 1	Column 2
1) eradicate	P) misrepresent
2) distort	Q) soak completely
3) saturate	R) use
4) utilize	S) destroy utterly

(A) 1:S, 2:P, 3:Q, 4:R (B) 1:P, 2:Q, 3:R, 4:S
(C) 1:Q, 2:R, 3:S, 4:P (D) 1:S, 2:P, 3:R, 4:Q

Q.4 What is the average of all multiples of 10 from 2 to 198?

(A) 90 (B) 100 (C) 110 (D) 120

Q.5 The value of $\sqrt{12+\sqrt{12+\sqrt{12+\cdots}}}$ is

(A) 3.464 (B) 3.932 (C) 4.000 (D) 4.444

Q. 6 – Q. 10 carry two marks each.

Q.6 The old city of Koenigsberg, which had a German majority population before World War 2, is now called Kaliningrad. After the events of the war, Kaliningrad is now a Russian territory and has a predominantly Russian population. It is bordered by the Baltic Sea on the north and the countries of Poland to the south and west and Lithuania to the east respectively. Which of the statements below can be inferred from this passage?

(A) Kaliningrad was historically Russian in its ethnic make up
(B) Kaliningrad is a part of Russia despite it not being contiguous with the rest of Russia
(C) Koenigsberg was renamed Kaliningrad, as that was its original Russian name
(D) Poland and Lithuania are on the route from Kaliningrad to the rest of Russia

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Q.7 The number of people diagnosed with dengue fever (contracted from the bite of a mosquito) in north India is twice the number diagnosed last year. Municipal authorities have concluded that measures to control the mosquito population have failed in this region.

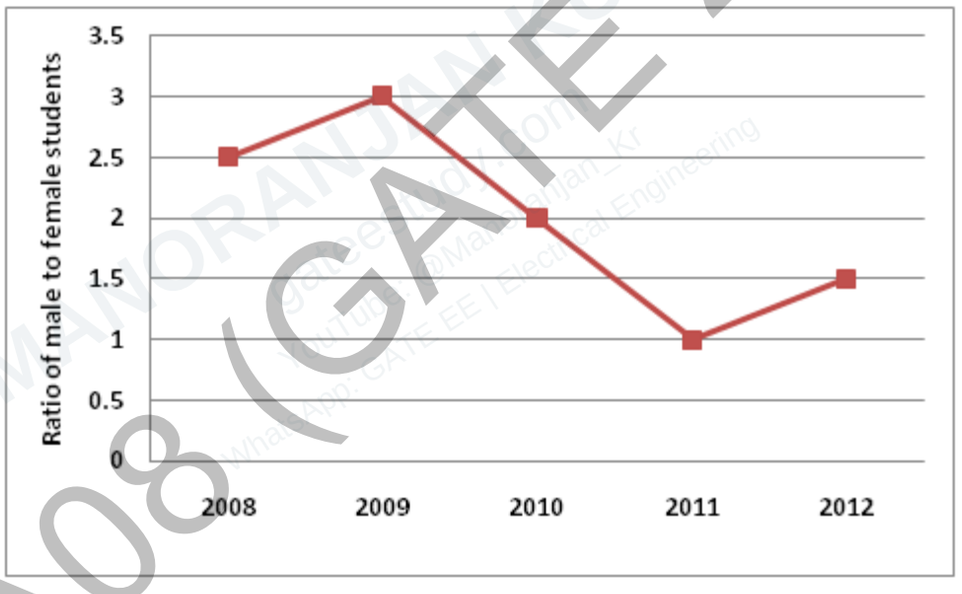
Which one of the following statements, if true, does not contradict this conclusion?

(A) A high proportion of the affected population has returned from neighbouring countries where dengue is prevalent
(B) More cases of dengue are now reported because of an increase in the Municipal Office's administrative efficiency
(C) Many more cases of dengue are being diagnosed this year since the introduction of a new and effective diagnostic test
(D) The number of people with malarial fever (also contracted from mosquito bites) has increased this year

Q.8 If x is real and $|x^2 - 2x + 3| = 11$, then possible values of $|-x^3 + x^2 - x|$ include

(A) 2, 4 (B) 2, 14 (C) 4, 52 (D) 14, 52

Q.9 The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students doubled in 2009, by what percent did the number of male students increase in 2009?



Q.10 At what time between 6 $a.m.$ and 7 $a.m.$ will the minute hand and hour hand of a clock make an angle closest to 60°?

(A) 6: 22 $a.m.$ (B) 6: 27 $a.m.$
(C) 6: 38 $a.m.$ (D) 6: 45 $a.m.$

END OF THE QUESTION PAPER

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Q. 1 – Q. 25 carry one mark each.

Q.1 Which one of the following statements is true for all real symmetric matrices?

(A) All the eigenvalues are real.
(B) All the eigenvalues are positive.
(C) All the eigenvalues are distinct.
(D) Sum of all the eigenvalues is zero.

Q.2 Consider a dice with the property that the probability of a face with n dots showing up is proportional to n. The probability of the face with three dots showing up is _____.

Q.3 Minimum of the real valued function $f(x) = (x-1)^{2/3}$ occurs at x equal to

(A) $-\infty$ (B) 0 (C) 1 (D) ∞

Q.4 All the values of the multi-valued complex function 1^i, where $i = \sqrt{-1}$, are

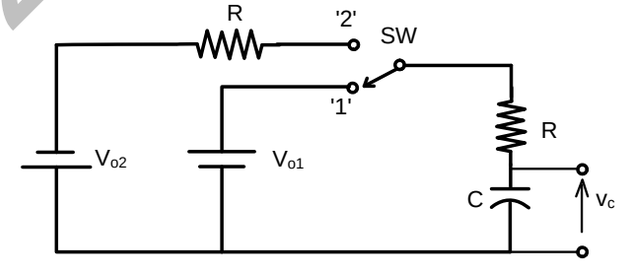
(A) purely imaginary.
(B) real and non-negative.
(C) on the unit circle.
(D) equal in real and imaginary parts.

Q.5 Consider the differential equation $x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0$. Which of the following is a solution to this differential equation for $x > 0$?

(A) e^x (B) x^2 (C) $1/x$ (D) $\ln x$

Q.6 Two identical coupled inductors are connected in series. The measured inductances for the two possible series connections are 380 μH and 240 μH. Their mutual inductance in μH is _____

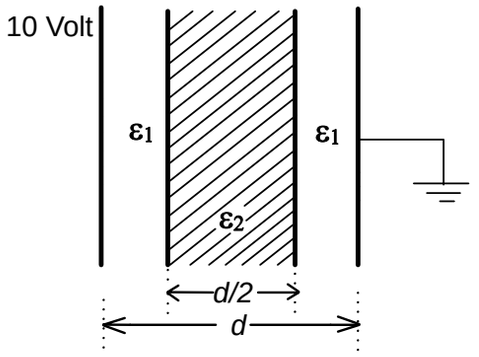
Q.7 The switch SW shown in the circuit is kept at position '1' for a long duration. At t = 0+, the switch is moved to position '2'. Assuming $|V_{o2}| > |V_{o1}|$, the voltage $v_c(t)$ across the capacitor is



(A) $v_c(t) = -V_{o2}(1-e^{-t/2RC}) - V_{o1}$
(B) $v_c(t) = V_{o2}(1-e^{-t/2RC}) + V_{o1}$
(C) $v_c(t) = -(V_{o2}+V_{o1})(1-e^{-t/2RC}) - V_{o1}$
(D) $v_c(t) = (V_{o2}-V_{o1})(1-e^{-t/2RC}) + V_{o1}$

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Q.8 A parallel plate capacitor consisting two dielectric materials is shown in the figure. The middle dielectric slab is placed symmetrically with respect to the plates.



If the potential difference between one of the plates and the nearest surface of dielectric interface is 2 Volts, then the ratio $\varepsilon_1 : \varepsilon_2$ is

(A) 1:4 (B) 2:3 (C) 3:2 (D) 4:1

Q.9 Consider an LTI system with transfer function

$$H(s) = \frac{1}{s\,(s+4)}$$

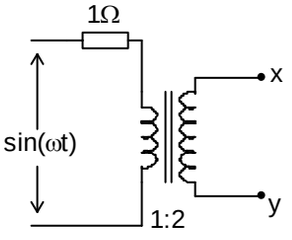
If the input to the system is $\cos(3t)$ and the steady state output is $A\sin(3t + \alpha)$, then the value of A is

(A) 1/30 (B) 1/15 (C) 3/4 (D) 4/3

Q.10 Consider an LTI system with impulse response $h(t) = e^{-5t}\,u(t)$. If the output of the system is $y(t) = e^{-3t}\,u(t) - e^{-5t}\,u(t)$ then the input, $x(t)$, is given by

(A) $e^{-3t}\,u(t)$ (B) $2\,e^{-3t}\,u(t)$
(C) $e^{-5t}\,u(t)$ (D) $2\,e^{-5t}\,u(t)$

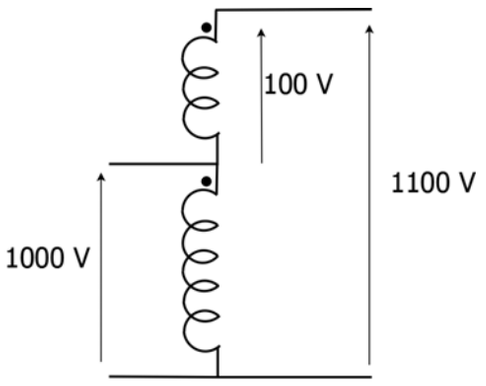
Q.11 Assuming an ideal transformer, the Thevenin's equivalent voltage and impedance as seen from the terminals x and y for the circuit in figure are



(A) $2\sin(\omega t)\,, 4\Omega$ (B) $1\sin(\omega t)\,, 1\Omega$
(C) $1\sin(\omega t)\,, 2\Omega$ (D) $2\sin(\omega t)\,, 0.5\Omega$

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Q.12 A single phase, 50 kVA, 1000V/100 V two winding transformer is connected as an autotransformer as shown in the figure.



The kVA rating of the autotransformer is _____.

Q.13 A three-phase, 4-pole, self excited induction generator is feeding power to a load at a frequency f_1. If the load is partially removed, the frequency becomes f_2. If the speed of the generator is maintained at 1500 rpm in both the cases, then

(A) $f_1, f_2 > 50$ Hz and $f_1 > f_2$
(B) $f_1 < 50$ Hz and $f_2 > 50$ Hz
(C) $f_1, f_2 < 50$ Hz and $f_2 > f_1$
(D) $f_1 > 50$ Hz and $f_2 < 50$ Hz

Q.14 A single phase induction motor draws 12 MW power at 0.6 lagging power. A capacitor is connected in parallel to the motor to improve the power factor of the combination of motor and capacitor to 0.8 lagging. Assuming that the real and reactive power drawn by the motor remains same as before, the reactive power delivered by the capacitor in MVAR is _____.

Q.15 A three phase star-connected load is drawing power at a voltage of 0.9 pu and 0.8 power factor lagging. The three phase base power and base current are 100 MVA and 437.38 A respectively. The line-to-line load voltage in kV is _____.

Q.16 Shunt reactors are sometimes used in high voltage transmission systems to

(A) limit the short circuit current through the line.
(B) compensate for the series reactance of the line under heavily loaded condition.
(C) limit over-voltages at the load side under lightly loaded condition.
(D) compensate for the voltage drop in the line under heavily loaded condition.

Q.17 The closed-loop transfer function of a system is $T(s) = \frac{4}{(s^2+0.4s+4)}$. The steady state error due to unit step input is _____.

Q.18 The state transition matrix for the system

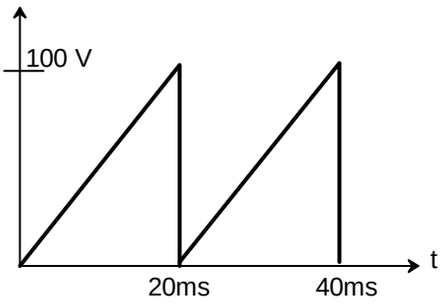
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 1\end{bmatrix}u$$

is

(A) $\begin{bmatrix}e^t & 0\\ e^t & e^t\end{bmatrix}$
(B) $\begin{bmatrix}e^t & 0\\ t^2e^t & e^t\end{bmatrix}$
(C) $\begin{bmatrix}e^t & 0\\ te^t & e^t\end{bmatrix}$
(D) $\begin{bmatrix}e^t & te^t\\ 0 & e^t\end{bmatrix}$

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Q.19 The saw-tooth voltage waveform shown in the figure is fed to a moving iron voltmeter. Its reading would be close to _____

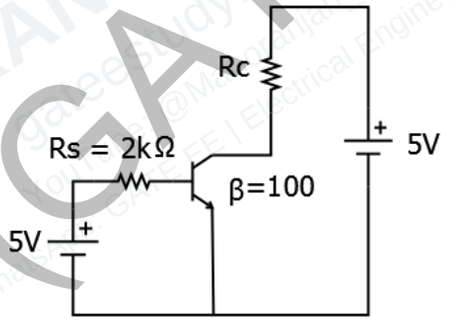


Q.20 While measuring power of a three-phase balanced load by the two-wattmeter method, the readings are 100 W and 250 W. The power factor of the load is _____.

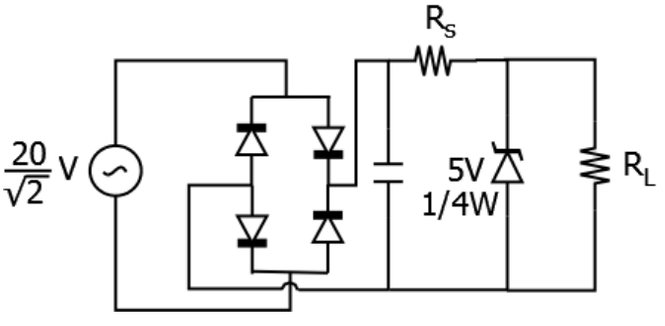
Q.21 Which of the following is an invalid state in an 8-4-2-1 Binary Coded Decimal counter

(A) 1 0 0 0 (B) 1 0 0 1 (C) 0 0 1 1 (D) 1 1 0 0

Q.22 The transistor in the given circuit should always be in active region. Take $V_{\mathrm{CE(sat)}} = 0.2$ V, $V_{\mathrm{BE}} = 0.7$ V. The maximum value of R_c in Ω which can be used, is _____.



Q.23 The sinusoidal ac source in the figure has an rms value of $\frac{20}{\sqrt{2}}$ V. Considering all possible values of R_L, the minimum value of R_s in Ω to avoid burnout of the Zener diode is _____.



Q.24 A step-up chopper is used to feed a load at 400 V dc from a 250 V dc source. The inductor current is continuous. If the 'off' time of the switch is 20 μs, the switching frequency of the chopper in kHz is _____.

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Q.25 In a constant *V/f* control of induction motor, the ratio *V/f* is maintained constant from 0 to base frequency, where *V* is the voltage applied to the motor at fundamental frequency *f*. Which of the following statements relating to low frequency operation of the motor is TRUE?

(A) At low frequency, the stator flux increases from its rated value.
(B) At low frequency, the stator flux decreases from its rated value.
(C) At low frequency, the motor saturates.
(D) At low frequency, the stator flux remains unchanged at its rated value.

Q. 26 – Q. 55 carry two marks each.

Q.26 To evaluate the double integral $\int_0^8 \left(\int_{y/2}^{(y/2)+1} \left(\frac{2x-y}{2}\right)\, dx\right) dy$, we make the substitution $u = \left(\frac{2x-y}{2}\right)$ and $v = \frac{y}{2}$. The integral will reduce to

(A) $\int_0^4 \left(\int_0^2 2\,u\, du\right) dv$
(B) $\int_0^4 \left(\int_0^1 2\,u\, du\right) dv$
(C) $\int_0^4 \left(\int_0^1 u\, du\right) dv$
(D) $\int_0^4 \left(\int_0^2 u\, du\right) dv$

Q.27 Let *X* be a random variable with probability density function

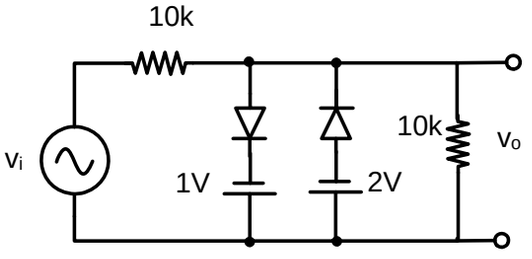
$$f(x) = \begin{cases} 0.2, & \text{for } |x| \le 1 \\ 0.1, & \text{for } 1 < |x| \le 4 \\ 0, & \text{otherwise.} \end{cases}$$

The probability $P(0.5 < X < 5)$ is _____.

Q.28 The minimum value of the function $f(x) = x^3 - 3x^2 - 24\,x + 100$ in the interval $[-3, 3]$ is

(A) 20
(B) 28
(C) 16
(D) 32

Q.29 Assuming the diodes to be ideal in the figure, for the output to be clipped, the input voltage v_i must be outside the range

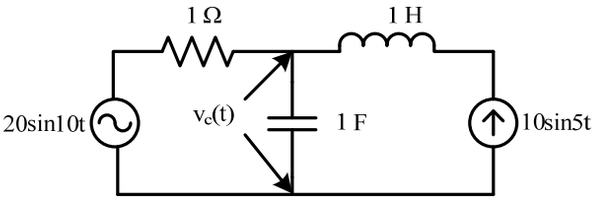


(A) -1 V to -2 V
(B) -2 V to -4 V
(C) +1 V to -2 V
(D) +2 V to -4 V

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Q.30 The voltage across the capacitor, as shown in the figure, is expressed as

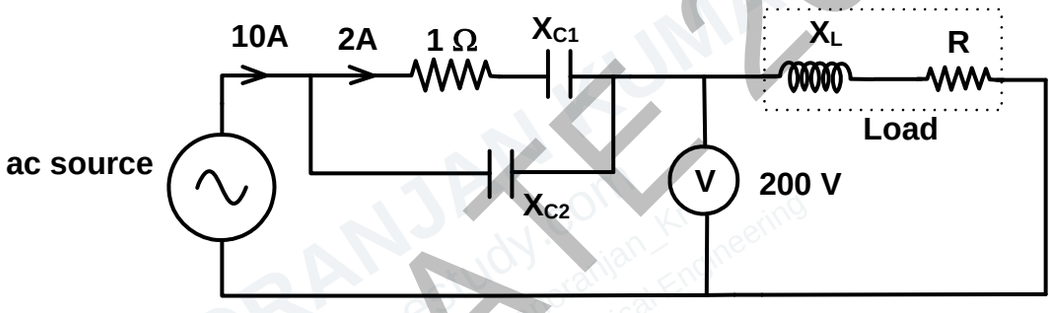
$$v_c(t) = A_1 \sin(\omega_1 t - \theta_1) + A_2 \sin(\omega_2 t - \theta_2)$$



The values of A_1 and A_2 respectively, are

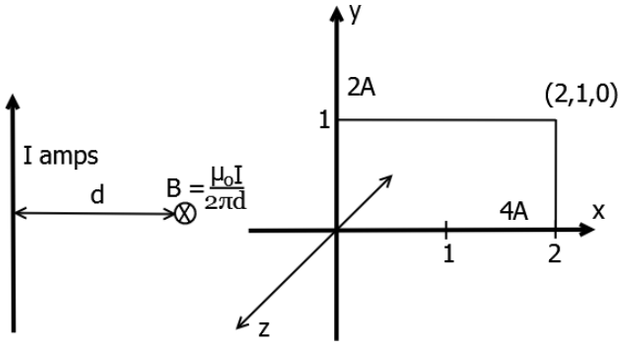
(A) 2.0 and 1.98 (B) 2.0 and 4.20 (C) 2.5 and 3.50 (D) 5.0 and 6.40

Q.31 The total power dissipated in the circuit, shown in the figure, is 1 kW.



The voltmeter, across the load, reads 200 V. The value of X_L is _____.

Q.32 The magnitude of magnetic flux density ($\vec{B}$) at a point having normal distance d meters from an infinitely extended wire carrying current of I A is $\frac{\mu_0 I}{2\pi d}$ (in SI units). An infinitely extended wire is laid along the x-axis and is carrying current of 4 A in the +ve x direction. Another infinitely extended wire is laid along the y-axis and is carrying 2 A current in the +ve y direction. μ_o is permeability of free space. Assume $\hat{\imath}$, $\hat{\jmath}$, $\hat{k}$ to be unit vectors along x, y and z axes respectively.



Assuming right handed coordinate system, magnetic field intensity, $\vec{H}$ at coordinate (2,1,0) will be

(A) $\frac{3}{2\pi}\,\hat{k}$ weber/m^2 (B) $\frac{4}{3\pi}\,\hat{\imath}$ A/m (C) $\frac{3}{2\pi}\,\hat{k}$ A/m (D) 0 A/m

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Q.33 A discrete system is represented by the difference equation

$$\begin{bmatrix} X_1(k+1) \\ X_2(k+1) \end{bmatrix} = \begin{bmatrix} a & a-1 \\ a+1 & a \end{bmatrix} \begin{bmatrix} X_1(k) \\ X_2(k) \end{bmatrix}$$

It has initial conditions $X_1(0) = 1$; $X_2(0) = 0$. The pole locations of the system for a = 1, are

(A) $1 \pm j0$ (B) $-1 \pm j0$ (C) $\pm 1 + j0$ (D) $0 \pm j1$

Q.34 An input signal $x(t) = 2 + 5\sin(100\pi t)$ is sampled with a sampling frequency of 400 Hz and applied to the system whose transfer function is represented by

$$\frac{Y(z)}{X(z)} = \frac{1}{N}\left(\frac{1-z^{-N}}{1-z^{-1}}\right)$$

where, N represents the number of samples per cycle. The output y(n) of the system under steady state is

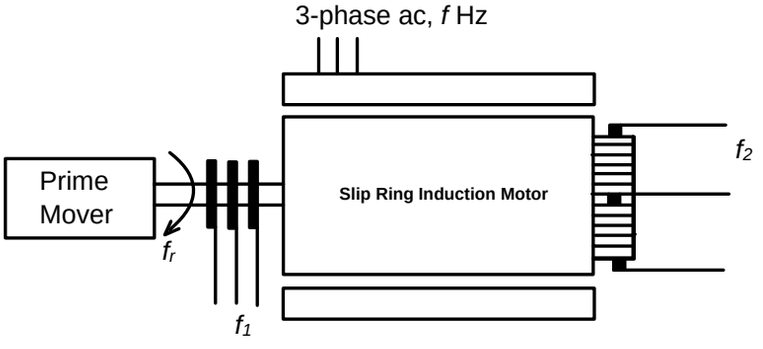
(A) 0 (B) 1 (C) 2 (D) 5

Q.35 A 10 kHz even-symmetric square wave is passed through a bandpass filter with centre frequency at 30 kHz and 3 dB passband of 6 kHz. The filter output is

(A) a highly attenuated square wave at 10 kHz.
(B) nearly zero.
(C) a nearly perfect cosine wave at 30 kHz.
(D) a nearly perfect sine wave at 30 kHz.

Q.36 A 250 V dc shunt machine has armature circuit resistance of 0.6 Ω and field circuit resistance of 125 Ω. The machine is connected to 250 V supply mains. The motor is operated as a generator and then as a motor separately. The line current of the machine in both the cases is 50 A. The ratio of the speed as a generator to the speed as a motor is _____.

Q.37 A three-phase slip-ring induction motor, provided with a commutator winding, is shown in the figure. The motor rotates in clockwise direction when the rotor windings are closed.



If the rotor winding is open circuited and the system is made to run at rotational speed f_r with the help of prime-mover in anti-clockwise direction, then the frequency of voltage across slip rings is f_1 and frequency of voltage across commutator brushes is f_2. The values of f_1 and f_2 respectively are

(A) $f + f_r$ and f (B) $f - f_r$ and f
(C) $f - f_r$ and $f + f_r$ (D) $f + f_r$ and $f - f_r$

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Q.38 A 20-pole alternator is having 180 identical stator slots with 6 conductors in each slot. All the coils of a phase are in series. If the coils are connected to realize single-phase winding, the generated voltage is V_1. If the coils are reconnected to realize three-phase star-connected winding, the generated phase voltage is V_2. Assuming full pitch, single-layer winding, the ratio V_1/V_2 is

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{2}$ (C) $\sqrt{3}$ (D) 2

Q.39 For a single phase, two winding transformer, the supply frequency and voltage are both increased by 10%. The percentage changes in the hysteresis loss and eddy current loss, respectively, are

(A) 10 and 21 (B) -10 and 21 (C) 21 and 10 (D) -21 and 10

Q.40 A synchronous generator is connected to an infinite bus with excitation voltage E_f = 1.3 pu. The generator has a synchronous reactance of 1.1 pu and is delivering real power (P) of 0.6 pu to the bus. Assume the infinite bus voltage to be 1.0 pu. Neglect stator resistance. The reactive power (Q) in pu supplied by the generator to the bus under this condition is _____.

Q.41 There are two generators in a power system. No-load frequencies of the generators are 51.5 Hz and 51 Hz, respectively, and both are having droop constant of 1 Hz/MW. Total load in the system is 2.5 MW. Assuming that the generators are operating under their respective droop characteristics, the frequency of the power system in Hz in the steady state is _____.

Q.42 The horizontally placed conductors of a single phase line operating at 50 Hz are having outside diameter of 1.6 cm, and the spacing between centers of the conductors is 6 m. The permittivity of free space is 8.854×10^{-12} F/m. The capacitance to ground per kilometer of each line is

(A) 4.2×10^{-9} F
(B) 8.4×10^{-9} F
(C) 4.2×10^{-12} F
(D) 8.4×10^{-12} F

Q.43 A three phase, 100 MVA, 25 kV generator has solidly grounded neutral. The positive, negative, and the zero sequence reactances of the generator are 0.2 pu, 0.2 pu, and 0.05 pu, respectively, at the machine base quantities. If a bolted single phase to ground fault occurs at the terminal of the unloaded generator, the fault current in amperes immediately after the fault is _____.

Q.44 A system with the open loop transfer function

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

is connected in a negative feedback configuration with a feedback gain of unity. For the closed loop system to be marginally stable, the value of K is _____

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Q.45 For the transfer function

$$G(s) = \frac{5(s+4)}{s(s+0.25)(s^2+4s+25)}$$

The values of the constant gain term and the highest corner frequency of the Bode plot respectively are

(A) 3.2, 5.0 (B) 16.0, 4.0 (C) 3.2, 4.0 (D) 16.0, 5.0

Q.46 The second order dynamic system

$$\frac{dX}{dt} = PX + Qu$$
$$y = RX$$

has the matrices P, Q and R as follows:

$$P = \begin{bmatrix} -1 & 1 \\ 0 & -3 \end{bmatrix} \quad Q = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad R = [0 \quad 1]$$

The system has the following controllability and observability properties:

(A) Controllable and observable
(B) Not controllable but observable
(C) Controllable but not observable
(D) Not controllable and not observable

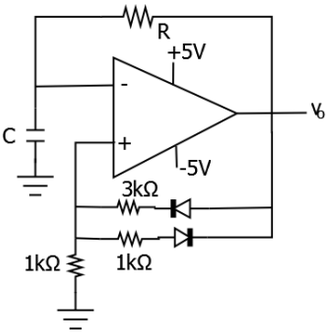
Q.47 Suppose that resistors R_1 and R_2 are connected in parallel to give an equivalent resistor R. If resistors R_1 and R_2 have tolerance of 1% each, the equivalent resistor R for resistors $R_1 = 300\ \Omega$ and $R_2 = 200\ \Omega$ will have tolerance of

(A) 0.5% (B) 1% (C) 1.2% (D) 2%

Q.48 Two ammeters X and Y have resistances of 1.2 Ω and 1.5 Ω respectively and they give full-scale deflection with 150 mA and 250 mA respectively. The ranges have been extended by connecting shunts so as to give full scale deflection with 15 A. The ammeters along with shunts are connected in parallel and then placed in a circuit in which the total current flowing is 15A. The current in amperes indicated in ammeter X is _____.

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YouTube: @Manoranjan_Kr
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Q.49 An oscillator circuit using ideal op-amp and diodes is shown in the figure.



The time duration for +ve part of the cycle is Δt_1 and for –ve part is Δt_2. The value of $e^{\frac{\Delta t_1 - \Delta t_2}{RC}}$ will be _____.

Q.50 The SOP (sum of products) form of a Boolean function is $\sum(0,1,3,7,11)$, where inputs are *A,B,C,D* (*A* is MSB, and *D* is LSB). The equivalent minimized expression of the function is

(A) $(\bar{B}+C)(\bar{A}+C)(\bar{A}+\bar{B})(\bar{C}+D)$

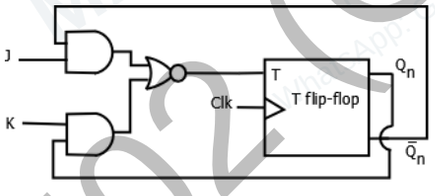
(B) $(\bar{B}+C)(\bar{A}+C)(\bar{A}+\bar{C})(\bar{C}+D)$

(C) $(\bar{B}+C)(\bar{A}+C)(\bar{A}+\bar{C})(\bar{C}+\bar{D})$

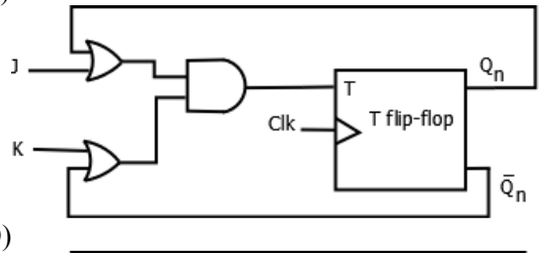
(D) $(\bar{B}+C)(A+\bar{B})(\bar{A}+\bar{B})(\bar{C}+D)$

Q.51 A JK flip flop can be implemented by T flip-flops. Identify the correct implementation.

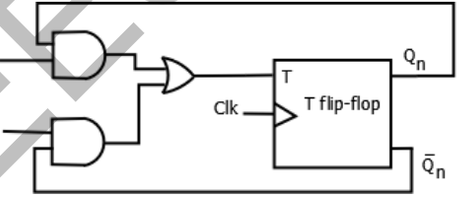
(A)



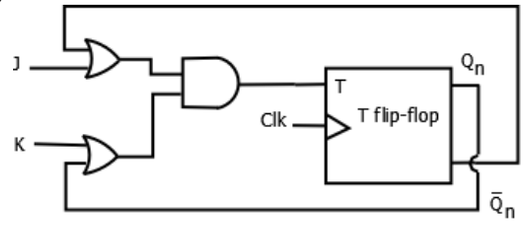
(B)



(C)



(D)



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Q.52 In an 8085 microprocessor, the following program is executed

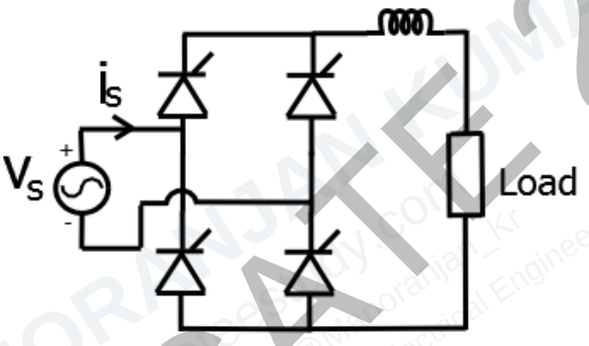
Address location – Instruction

2000H	XRA A
2001H	MVI B,04H
2003H	MVI A, 03H
2005H	RAR
2006H	DCR B
2007H	JNZ 2005
200AH	HLT

At the end of program, register A contains

(A) 60H (B) 30H (C) 06H (D) 03H

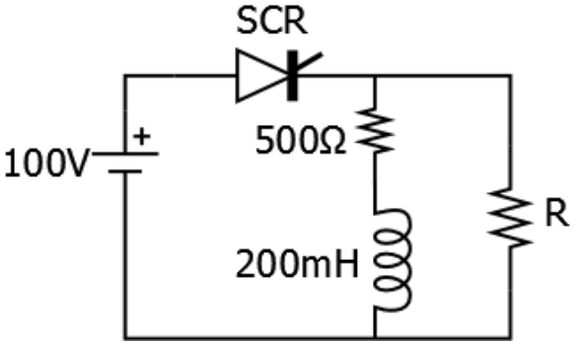
Q.53 A fully controlled converter bridge feeds a highly inductive load with ripple free load current. The input supply (v_s) to the bridge is a sinusoidal source. Triggering angle of the bridge converter is $\alpha = 30^0$. The input power factor of the bridge is _____.



Q.54 A single-phase SCR based ac regulator is feeding power to a load consisting of 5 Ω resistance and 16 mH inductance. The input supply is 230 V, 50 Hz ac. The maximum firing angle at which the voltage across the device becomes zero all throughout and the rms value of current through SCR, under this operating condition, are

(A) 30^0 and 46 A (B) 30^0 and 23 A
(C) 45^0 and 23 A (D) 45^0 and 32 A

Q.55 The SCR in the circuit shown has a latching current of 40 mA. A gate pulse of 50 μs is applied to the SCR. The maximum value of R in Ω to ensure successful firing of the SCR is _____.



END OF THE QUESTION PAPER

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Answer Keys for EE - Electrical Engineering

Section	Q. No.	SESSION - H	
		Key / Range	Marks
GA	1	A	1
GA	2	B	1
GA	3	A	1
GA	4	B	1
GA	5	C	1
GA	6	B	2
GA	7	D	2
GA	8	D	2
GA	9	140 to 140	2
GA	10	A	2
EE	1	A	1
EE	2	0.13 to 0.15	1
EE	3	C	1
EE	4	B	1
EE	5	C	1
EE	6	35 to 35	1
EE	7	D	1
EE	8	C	1
EE	9	B	1
EE	10	B	1
EE	11	A	1
EE	12	545 to 555	1
EE	13	C	1
EE	14	6.97 to 7.03	1
EE	15	117 to 120	1
EE	16	C	1
EE	17	0 to 0	1
EE	18	C	1
EE	19	56 to 59	1
EE	20	0.78 to 0.82	1
EE	21	D	1
EE	22	22 to 23	1
EE	23	299 to 301	1

Section	Q. No.	SESSION - H	
		Key / Range	Marks
EE	24	31.0 to 31.5	1
EE	25	B	1
EE	26	B	2
EE	27	0.35 to 0.45	2
EE	28	B	2
EE	29	B	2
EE	30	A	2
EE	31	17.3 to 17.4	2
EE	32	C	2
EE	33	A	2
EE	34	C	2
EE	35	C	2
EE	36	1.22 to 1.32	2
EE	37	A	2
EE	38	D	2
EE	39	A	2
EE	40	0.10 to 0.12	2
EE	41	49.9 to 50.1	2
EE	42	B	2
EE	43	15300 to 15500	2
EE	44	5 to 5	2
EE	45	A	2
EE	46	C	2
EE	47	B	2
EE	48	9.9 to 10.3	2
EE	49	1.2 to 1.3	2
EE	50	A	2
EE	51	B	2
EE	52	A	2
EE	53	0.74 to 0.82	2
EE	54	C	2
EE	55	6055 to 6065	2

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SESSION - 3

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gateestudy.com
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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.

MANORANJAN KUMAR
gateestudy.com
YouTube: @Manoranjan_Kr
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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.*

<u>Navigating to a Question :</u>

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.

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GATE 2014 Examination

EE: Electrical 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 While trying to collect (I) an envelope from under the table (II), Mr. X fell down (III) and was losing consciousness (IV).

Which one of the above underlined parts of the sentence is NOT appropriate?

(A) I (B) II (C) III (D) IV

Q.2 If she _____ how to calibrate the instrument, she _____ done the experiment.

(A) knows, will have (B) knew, had
(C) had known, could have (D) should have known, would have

Q.3 Choose the word that is opposite in meaning to the word "coherent".

(A) sticky (B) well-connected (C) rambling (D) friendly

Q.4 Which number does not belong in the series below?
2, 5, 10, 17, 26, 37, 50, 64

(A) 17 (B) 37 (C) 64 (D) 26

Q.5 The table below has question-wise data on the performance of students in an examination. The marks for each question are also listed. There is no negative or partial marking in the examination.

Q No.	Marks	Answered Correctly	Answered Wrongly	Not Attempted
1	2	21	17	6
2	3	15	27	2
3	2	23	18	3

What is the average of the marks obtained by the class in the examination?

(A) 1.34 (B) 1.74 (C) 3.02 (D) 3.91

Q. 6 – Q. 10 carry two marks each.

Q.6 A dance programme is scheduled for 10.00 a.m. Some students are participating in the programme and they need to come an hour earlier than the start of the event. These students should be accompanied by a parent. Other students and parents should come in time for the programme. The instruction you think that is appropriate for this is

(A) Students should come at 9.00 a.m. and parents should come at 10.00 a.m.
(B) Participating students should come at 9.00 a.m. accompanied by a parent, and other parents and students should come by 10.00 a.m.
(C) Students who are not participating should come by 10.00 a.m. and they should not bring their parents. Participating students should come at 9.00 a.m.
(D) Participating students should come before 9.00 a.m. Parents who accompany them should come at 9.00 a.m. All others should come at 10.00 a.m.

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Q.7 By the beginning of the 20th century, several hypotheses were being proposed, suggesting a paradigm shift in our understanding of the universe. However, the clinching evidence was provided by experimental measurements of the position of a star which was directly behind our sun.

Which of the following inference(s) may be drawn from the above passage?

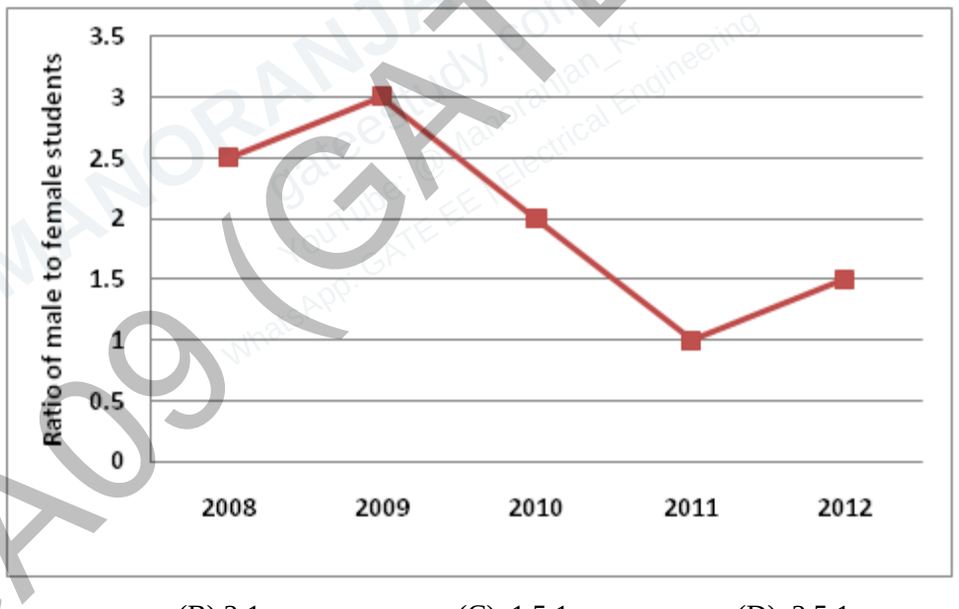
(i) Our understanding of the universe changes based on the positions of stars
(ii) Paradigm shifts usually occur at the beginning of centuries
(iii) Stars are important objects in the universe
(iv) Experimental evidence was important in confirming this paradigm shift

(A) (i), (ii) and (iv) (B) (iii) only (C) (i) and (iv) (D) (iv) only

Q.8 The Gross Domestic Product (GDP) in Rupees grew at 7% during 2012-2013. For international comparison, the GDP is compared in US Dollars (USD) after conversion based on the market exchange rate. During the period 2012-2013 the exchange rate for the USD increased from Rs. 50/ USD to Rs. 60/ USD. India's GDP in USD during the period 2012-2013

(A) increased by 5 %
(B) decreased by 13%
(C) decreased by 20%
(D) decreased by 11%

Q.9 The ratio of male to female students in a college for five years is plotted in the following line graph. If the number of female students in 2011 and 2012 is equal, what is the ratio of male students in 2012 to male students in 2011?



(A) 1:1 (B) 2:1 (C) 1.5:1 (D) 2.5:1

Q.10 Consider the equation: $(7526)_8 - (Y)_8 = (4364)_8$, where $(X)_N$ stands for X to the base N. Find Y.

(A) 1634 (B) 1737 (C) 3142 (D) 3162

END OF THE QUESTION PAPER

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Q. 1 – Q. 25 carry one mark each.

Q.1 Two matrices A and B are given below:

$$A=\begin{bmatrix} p & q \\ r & s \end{bmatrix}; \qquad B=\begin{bmatrix} p^2+q^2 & pr+qs \\ pr+qs & r^2+s^2 \end{bmatrix}$$

If the rank of matrix A is N, then the rank of matrix B is

(A) $N/2$ (B) N-1 (C) N (D) $2N$

Q.2 A particle, starting from origin at t = 0 s, is traveling along x-axis with velocity

$$\mathbf{v}=\frac{\pi}{2}\cos\left(\frac{\pi}{2}t\right)\text{m/s}$$

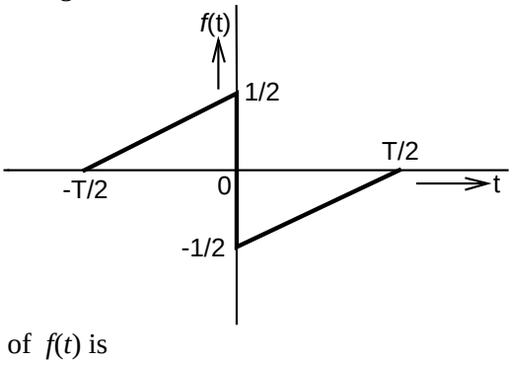
At t = 3 s, the difference between the distance covered by the particle and the magnitude of displacement from the origin is _____.

Q.3 Let $\nabla\cdot(f\,\mathbf{v})=x^2y+y^2z+z^2x$, where f and $\mathbf{v}$ are scalar and vector fields respectively. If $\mathbf{v}=y\mathbf{i}+z\mathbf{j}+x\mathbf{k}$, then $\mathbf{v}\cdot\nabla f$ is

(A) $x^2y+y^2z+z^2x$ (B) $2xy+2yz+2zx$
(C) $x+y+z$ (D) 0

Q.4 Lifetime of an electric bulb is a random variable with density $f(x) = kx^2$, where x is measured in years. If the minimum and maximum lifetimes of bulb are 1 and 2 years respectively, then the value of k is _____.

Q.5 A function $f(t)$ is shown in the figure.



The Fourier transform $F(\omega)$ of $f(t)$ is

(A) real and even function of ω. (B) real and odd function of ω.
(C) imaginary and odd function of ω. (D) imaginary and even function of ω.

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Q.6 The line *A* to neutral voltage is $10\angle 15^\circ$ V for a balanced three phase star-connected load with phase sequence *ABC*. The voltage of line *B* with respect to line *C* is given by

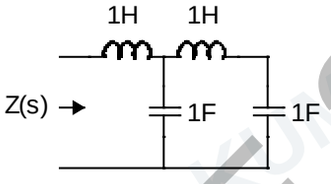
(A) $10\sqrt{3}\angle 105^\circ$ V (B) $10\angle 105^\circ$ V

(C) $10\sqrt{3}\angle -75^\circ$ V (D) $-10\sqrt{3}\angle 90^\circ$ V

Q.7 A hollow metallic sphere of radius *r* is kept at potential of 1 Volt. The total electric flux coming out of the concentric spherical surface of radius *R* (> *r*) is

(A) $4\pi\varepsilon_0 r$ (B) $4\pi\varepsilon_0 r^2$ (C) $4\pi\varepsilon_0 R$ (D) $4\pi\varepsilon_0 R^2$

Q.8 The driving point impedance Z(s) for the circuit shown below is



(A) $\frac{s^4+3s^2+1}{s^3+2s}$ (B) $\frac{s^4+2s^2+4}{s^2+2}$

(C) $\frac{s^2+1}{s^4+s^2+1}$ (D) $\frac{s^3+1}{s^4+s^2+1}$

Q.9 A signal is represented by

$$x(t)=\begin{cases}1 & |t|<1\\ 0 & |t|>1\end{cases}$$

The Fourier transform of the convolved signal $y(t)=x(2t)*x(t/2)$ is

(A) $\frac{4}{\omega^2}\sin\left(\frac{\omega}{2}\right)\sin(2\omega)$ (B) $\frac{4}{\omega^2}\sin\left(\frac{\omega}{2}\right)$

(C) $\frac{4}{\omega^2}\sin(2\omega)$ (D) $\frac{4}{\omega^2}\sin^2\omega$

Q.10 For the signal $f(t) = 3\sin 8\pi t + 6\sin 12\pi t + \sin 14\pi t$, the minimum sampling frequency (in Hz) satisfying the Nyquist criterion is _____.

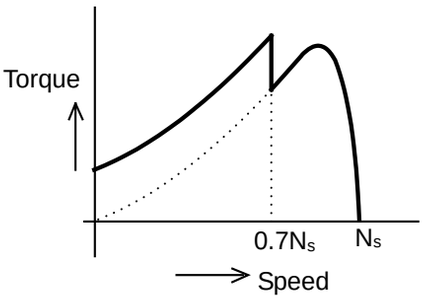
Q.11 In a synchronous machine, hunting is predominantly damped by

(A) mechanical losses in the rotor
(B) iron losses in the rotor
(C) copper losses in the stator
(D) copper losses in the rotor

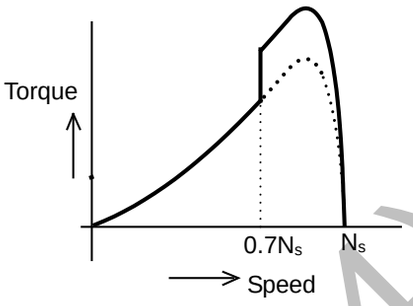
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Q.12 A single phase induction motor is provided with capacitor and centrifugal switch in series with auxiliary winding. The switch is expected to operate at a speed of 0.7 Ns, but due to malfunctioning the switch fails to operate. The torque-speed characteristic of the motor is represented by

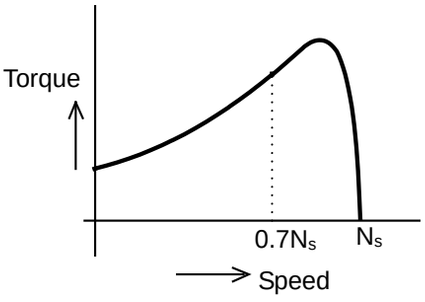
(A)



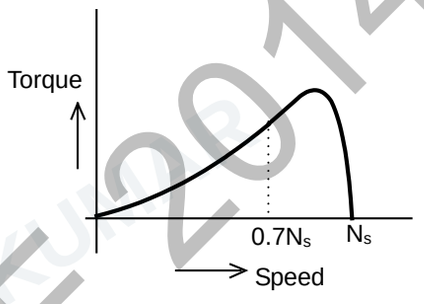
(B)



(C)



(D)



Q.13 The no-load speed of a 230 V separately excited dc motor is 1400 rpm. The armature resistance drop and the brush drop are neglected. The field current is kept constant at rated value. The torque of the motor in Nm for an armature current of 8 A is _____.

Q.14 In a long transmission line with r, l, g and c are the resistance, inductance, shunt conductance and capacitance per unit length, respectively, the condition for distortionless transmission is

(A) $rc = lg$
(B) $r = \sqrt{l/c}$
(C) $rg = lc$
(D) $g = \sqrt{c/l}$

Q.15 For a fully transposed transmission line

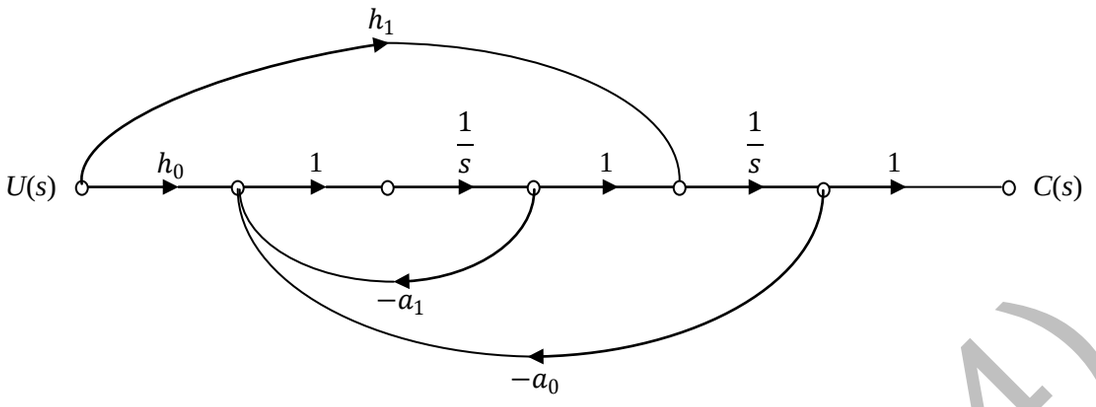
(A) positive, negative and zero sequence impedances are equal
(B) positive and negative sequence impedances are equal
(C) zero and positive sequence impedances are equal
(D) negative and zero sequence impedances are equal

Q.16 A 183-bus power system has 150 PQ buses and 32 PV buses. In the general case, to obtain the load flow solution using Newton-Raphson method in polar coordinates, the minimum number of simultaneous equations to be solved is _____.

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Q.17 The signal flow graph of a system is shown below. $U(s)$ is the input and $C(s)$ is the output.



.

Assuming, $h_1 = b_1$ and $h_0 = b_0 - b_1 a_1$, the input-output transfer function, $G(s) = \frac{C(s)}{U(s)}$ of the system is given by

(A) $G(s) = \frac{b_0 s + b_1}{s^2 + a_0 s + a_1}$

(B) $G(s) = \frac{a_1 s + a_0}{s^2 + b_1 s + b_0}$

(C) $G(s) = \frac{b_1 s + b_0}{s^2 + a_1 s + a_0}$

(D) $G(s) = \frac{a_0 s + a_1}{s^2 + b_0 s + b_1}$

Q.18 A single-input single-output feedback system has forward transfer function $G(s)$ and feedback transfer function $H(s)$. It is given that $|G(s)H(s)| < 1$. Which of the following is true about the stability of the system?

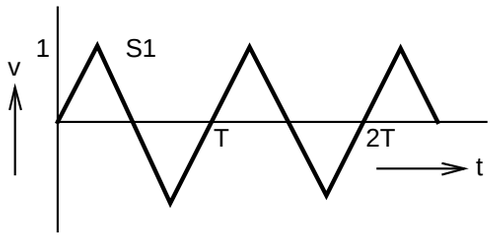
(A) The system is always stable
(B) The system is stable if all zeros of $G(s)H(s)$ are in left half of the *s*-plane
(C) The system is stable if all poles of $G(s)H(s)$ are in left half of the *s*-plane
(D) It is not possible to say whether or not the system is stable from the information given

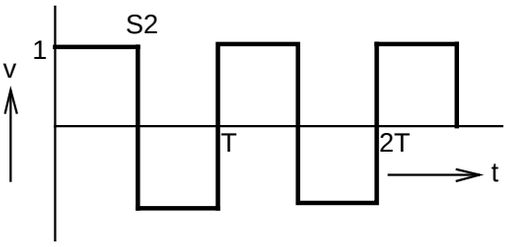
Q.19 An LPF wattmeter of power factor 0.2 is having three voltage settings 300 V, 150 V and 75 V, and two current settings 5 A and 10 A. The full scale reading is 150. If the wattmeter is used with 150 V voltage setting and 10 A current setting, the multiplying factor of the wattmeter is _____.

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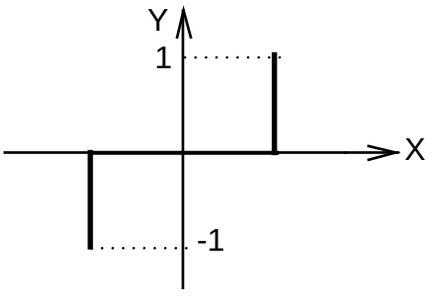
Q.20 The two signals S1 and S2, shown in figure, are applied to Y and X deflection plates of an oscilloscope.



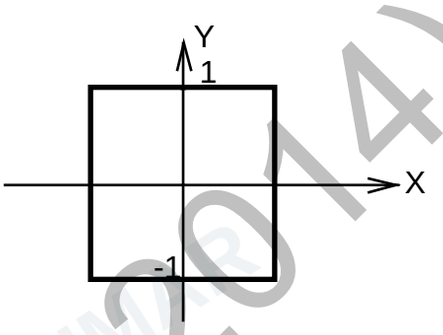


The waveform displayed on the screen is

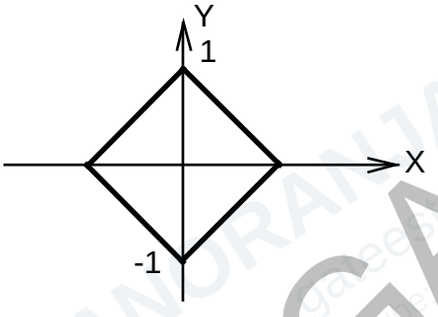
(A)



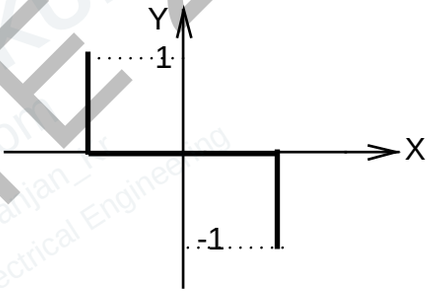
(B)



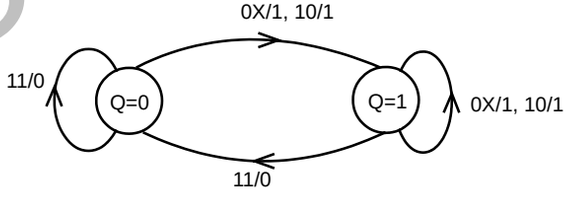
(C)



(D)



Q.21 A state diagram of a logic gate which exhibits a delay in the output is shown in the figure, where X is the don't care condition, and Q is the output representing the state.

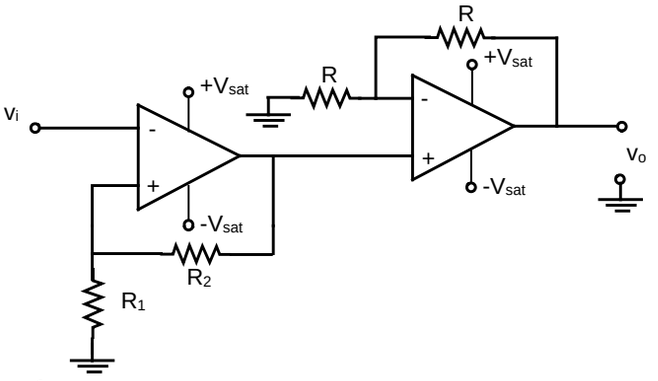


The logic gate represented by the state diagram is

(A) XOR (B) OR (C) AND (D) NAND

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Q.22 An operational-amplifier circuit is shown in the figure.



The output of the circuit for a given input v_i is

(A) $-\left(\frac{R_2}{R_1}\right)v_i$ (B) $-\left(1+\frac{R_2}{R_1}\right)v_i$

(C) $\left(1+\frac{R_2}{R_1}\right)v_i$ (D) + V_{sat} or -V_{sat}

Q.23 In 8085A microprocessor, the operation performed by the instruction LHLD 2100_H is

(A) $(H) \leftarrow 21_H$, $(L) \leftarrow 00_H$

(B) $(H) \leftarrow M(2100_H)$, $(L) \leftarrow M(2101_H)$

(C) $(H) \leftarrow M(2101_H)$, $(L) \leftarrow M(2100_H)$

(D) $(H) \leftarrow 00_H$, $(L) \leftarrow 21_H$

Q.24 A non-ideal voltage source V_s has an internal impedance of Z_s. If a purely resistive load is to be chosen that maximizes the power transferred to the load, its value must be

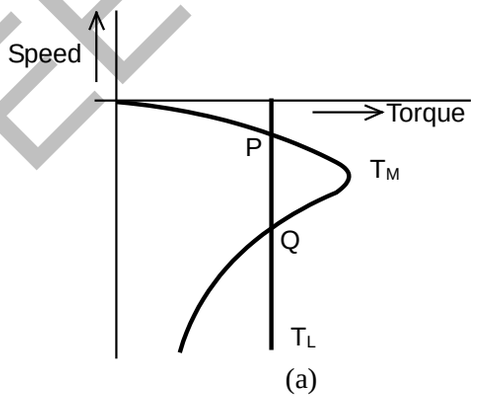
(A) 0

(B) real part of Z_s

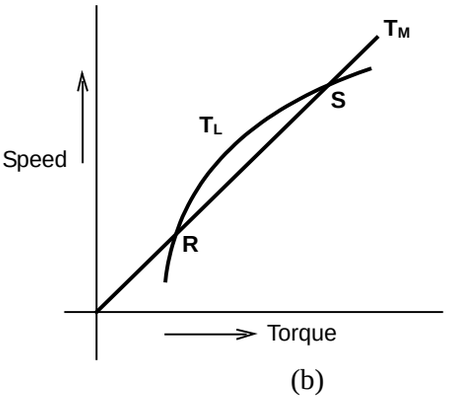
(C) magnitude of Z_s

(D) complex conjugate of Z_s

Q.25 The torque-speed characteristics of motor (T_M) and load (T_L) for two cases are shown in the figures (a) and (b). The load torque is equal to motor torque at points P, Q, R and S



(a)



(b)

The stable operating points are

(A) P and R (B) P and S (C) Q and R (D) Q and S

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Q. 26 – Q. 55 carry two marks each.

Q.26 Integration of the complex function $f(z)=\frac{z^2}{z^2-1}$, in the counterclockwise direction, around $|z-1| = 1$, is

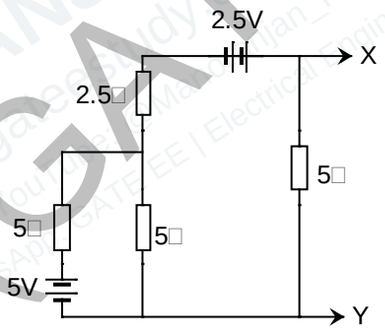
(A) $-\pi i$ (B) 0 (C) πi (D) $2\pi i$

Q.27 The mean thickness and variance of silicon steel laminations are 0.2 mm and 0.02 respectively. The varnish insulation is applied on both the sides of the laminations. The mean thickness of one side insulation and its variance are 0.1 mm and 0.01 respectively. If the transformer core is made using 100 such varnish coated laminations, the mean thickness and variance of the core respectively are

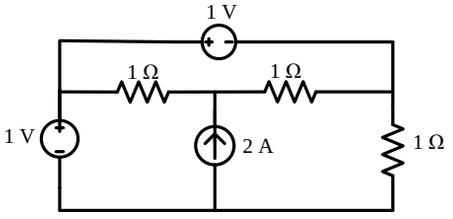
(A) 30 mm and 0.22 (B) 30 mm and 2.44 (C) 40 mm and 2.44 (D) 40 mm and 0.24

Q.28 The function $f(x)=e^x-1$ is to be solved using Newton-Raphson method. If the initial value of x_0 is taken as 1.0, then the absolute error observed at 2nd iteration is _____.

Q.29 The Norton's equivalent source in amperes as seen into the terminals X and Y is _____.

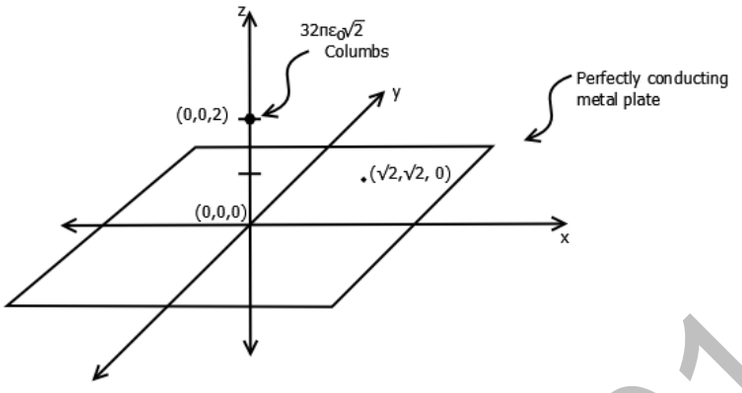


Q.30 The power delivered by the current source, in the figure, is _____.



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Q.31 A perfectly conducting metal plate is placed in x-y plane in a right handed coordinate system. A charge of $+32\pi\varepsilon_o\sqrt{2}$ columbs is placed at coordinate (0, 0, 2). ϵ_o is the permittivity of free space. Assume $\hat{\imath}$, $\hat{\jmath}$, $\hat{k}$ to be unit vectors along x, y and z axes respectively. At the coordinate $(\sqrt{2}, \sqrt{2}, 0)$, the electric field vector $\vec{E}$ (Newtons/Columb) will be

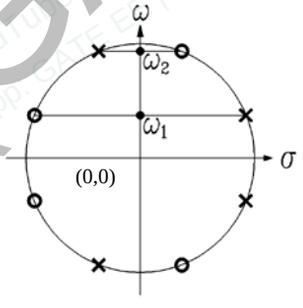


(A) $2\sqrt{2}\,\hat{k}$ (B) $-2\,\hat{k}$ (C) $2\,\hat{k}$ (D) $-2\sqrt{2}\,\hat{k}$

Q.32 A series RLC circuit is observed at two frequencies. At $\omega_1 = 1$ krad/s, we note that source voltage $V_1 = 100\angle 0°$ V results in a current $I_1 = 0.03\angle 31°$ A. At $\omega_2 = 2$ krad/s, the source voltage $V_2 = 100\angle 0°$ V results in a current $I_2 = 2\angle 0°$ A. The closest values for R, L, C out of the following options are

(A) $R = 50\ \Omega; L = 25$ mH; $C = 10$ μF;
(B) $R = 50\ \Omega; L = 10$ mH; $C = 25$ μF;
(C) $R = 50\ \Omega; L = 50$ mH; $C = 5$ μF;
(D) $R = 50\ \Omega; L = 5$ mH; $C = 50$ μF;

Q.33 A continuous-time LTI system with system function $H(\omega)$ has the following pole-zero plot. For this system, which of the alternatives is TRUE?



(A) $|H(0)| > |H(\omega)|; |\omega| > 0$
(B) $|H(\omega)|$ has multiple maxima, at ω_1 and ω_2
(C) $|H(0)| < |H(\omega)|; |\omega| > 0$
(D) $|H(\omega)| = \text{constant}; -\infty < \omega < \infty$

Q.34 A sinusoid $x(t)$ of unknown frequency is sampled by an impulse train of period 20 ms. The resulting sample train is next applied to an ideal lowpass filter with a cutoff at 25 Hz. The filter output is seen to be a sinusoid of frequency 20 Hz. This means that $x(t)$ has a frequency of

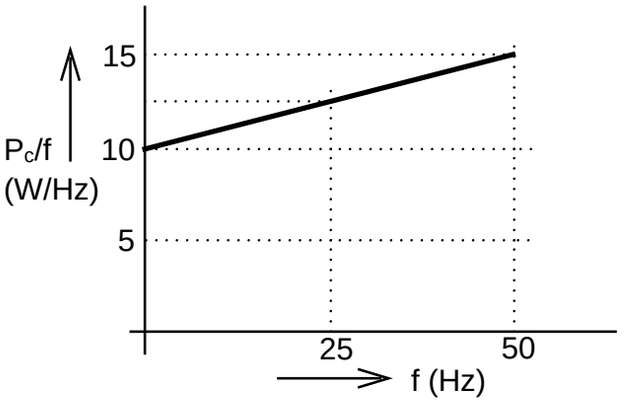
(A) 10 Hz (B) 60 Hz (C) 30 Hz (D) 90 Hz

Q.35 A differentiable non constant even function $x(t)$ has a derivative $y(t)$, and their respective Fourier Transforms are $X(\omega)$ and $Y(\omega)$. Which of the following statements is TRUE?

(A) $X(\omega)$ and $Y(\omega)$ are both real.
(B) $X(\omega)$ is real and $Y(\omega)$ is imaginary.
(C) $X(\omega)$ and $Y(\omega)$ are both imaginary.
(D) $X(\omega)$ is imaginary and $Y(\omega)$ is real.

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Q.36 An open circuit test is performed on 50 Hz transformer, using variable frequency source and keeping V/f ratio constant, to separate its eddy current and hysteresis losses. The variation of core loss/frequency as function of frequency is shown in the figure



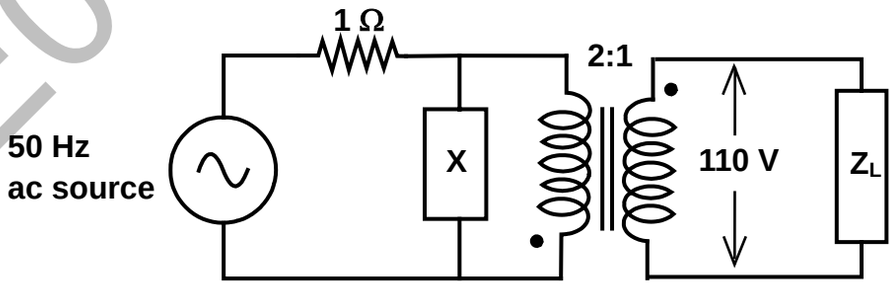
The hysteresis and eddy current losses of the transformer at 25 Hz respectively are

(A) 250 W and 2.5 W
(B) 250 W and 62.5W
(C) 312.5 W and 62.5 W
(D) 312.5 W and 250 W

Q.37 A non-salient pole synchronous generator having synchronous reactance of 0.8 pu is supplying 1 pu power to a unity power factor load at a terminal voltage of 1.1 pu. Neglecting the armature resistance, the angle of the voltage behind the synchronous reactance with respect to the angle of the terminal voltage in degrees is _____.

Q.38 A separately excited 300 V DC shunt motor under no load runs at 900 rpm drawing an armature current of 2 A. The armature resistance is 0.5 Ω and leakage inductance is 0.01 H. When loaded, the armature current is 15 A. Then the speed in rpm is _____

Q.39 The load shown in the figure absorbs 4 kW at a power factor of 0.89 lagging.



Assuming the transformer to be ideal, the value of the reactance X to improve the input power factor to unity is _____.

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Q.40 The parameters measured for a 220V/110V, 50 Hz, single-phase transformer are:

Self inductance of primary winding = 45 mH
Self inductance of secondary winding = 30 mH
Mutual inductance between primary and secondary windings = 20 mH

Using the above parameters, the leakage (L_{l1} , L_{l2}) and magnetizing (L_m) inductances as referred to primary side in the equivalent circuit respectively, are

(A) 5mH, 20mH and 40mH (B) 5mH, 80mH and 40mH

(C) 25mH, 10mH and 20mH (D) 45mH, 30mH and 20mH

Q.41 For a 400 km long transmission line, the series impedance is (0.0 + j0.5) Ω/km and the shunt admittance is (0.0 + j5.0) μmho/km. The magnitude of the series impedance (in Ω) of the equivalent π circuit of the transmission line is _____.

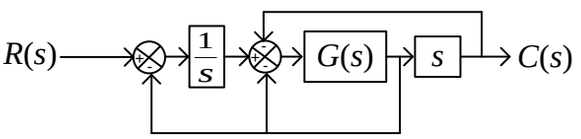
Q.42 The complex power consumed by a constant-voltage load is given by $(P_1 + jQ_1)$, where, $1\text{ kW} \le P_1 \le 1.5\text{ kW}$ and $0.5\text{ kVAR} \le Q_1 \le 1\text{ kVAR}$.
A compensating shunt capacitor is chosen such that $|Q| \le 0.25$ kVAR, where Q is the net reactive power consumed by the capacitor-load combination. The reactive power (in kVAR) supplied by the capacitor is _____.

Q.43 The figure shows the single line diagram of a single machine infinite bus system.



The inertia constant of the synchronous generator $H = 5$ MW-s/MVA. Frequency is 50 Hz. Mechanical power is 1 pu. The system is operating at the stable equilibrium point with rotor angle δ equal to 30^o. A three phase short circuit fault occurs at a certain location on one of the circuits of the double circuit transmission line. During fault, electrical power in pu is $P_{max} \sin\delta$. If the values of δ and $d\delta/dt$ at the instant of fault clearing are 45^o and 3.762 radian/s respectively, then P_{max} (in pu) is _____.

Q.44 The block diagram of a system is shown in the figure



If the desired transfer function of the system is

$$\frac{C(s)}{R(s)} = \frac{s}{s^2 + s + 1}$$

then $G(s)$ is

(A) 1 (B) s (C) $1/s$ (D) $\dfrac{-s}{s^3 + s^2 - s - 2}$

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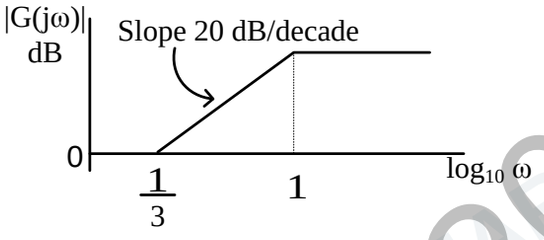
Q.45 Consider the system described by following state space equations

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 1\end{bmatrix}u\ ; \qquad y=\begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

If u is unit step input, then the steady state error of the system is

(A) 0 (B) 1/2 (C) 2/3 (D) 1

Q.46 The magnitude Bode plot of a network is shown in the figure



The maximum phase angle ϕ_m and the corresponding gain G_m respectively, are

(A) $-30°$ and 1.73dB (B) $-30°$ and 4.77dB
(C) $+30°$ and 4.77dB (D) $+30°$ and 1.73dB

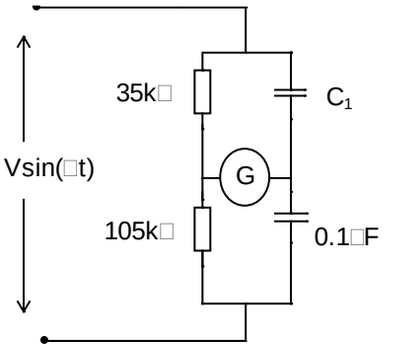
Q.47 A periodic waveform observed across a load is represented by

$$V(t)=\begin{cases}1+\sin\omega t & 0\le\omega t<6\pi\\ -1+\sin\omega t & 6\pi\le\omega t<12\pi\end{cases}$$

The measured value, using moving iron voltmeter connected across the load, is

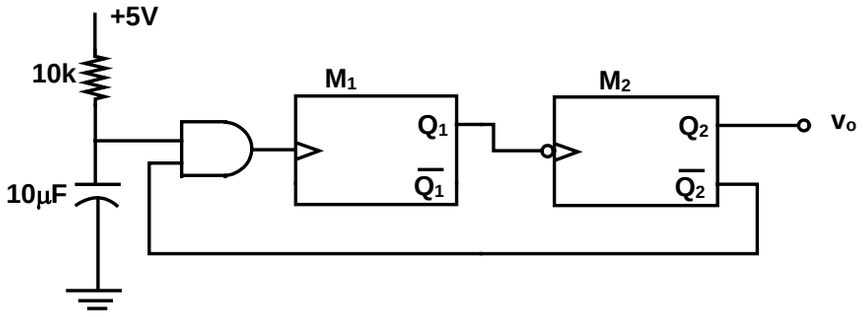
(A) $\sqrt{\frac{3}{2}}$ (B) $\sqrt{\frac{2}{3}}$ (C) $\frac{3}{2}$ (D) $\frac{2}{3}$

Q.48 In the bridge circuit shown, the capacitors are loss free. At balance, the value of capacitance C_1 in microfarad is _____.



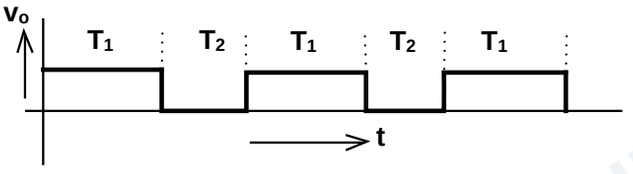
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Q.49 Two monoshot multivibrators, one positive edge triggered (M_1) and another negative edge triggered (M_2), are connected as shown in figure

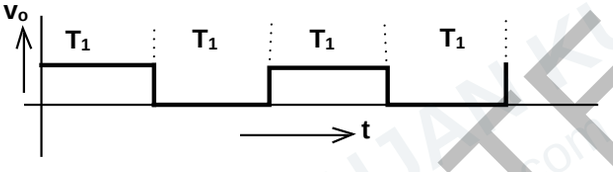


The monoshots M_1 and M_2 when triggered produce pulses of width T_1 and T_2 respectively, where $T_1 > T_2$. The steady state output voltage v_o of the circuit is

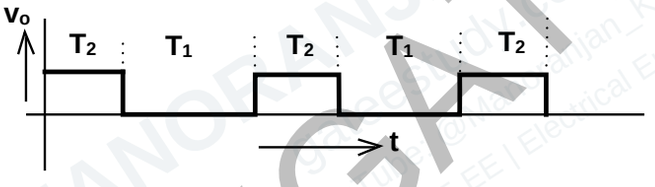
(A)



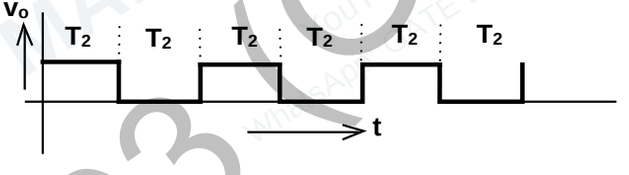
(B)



(C)

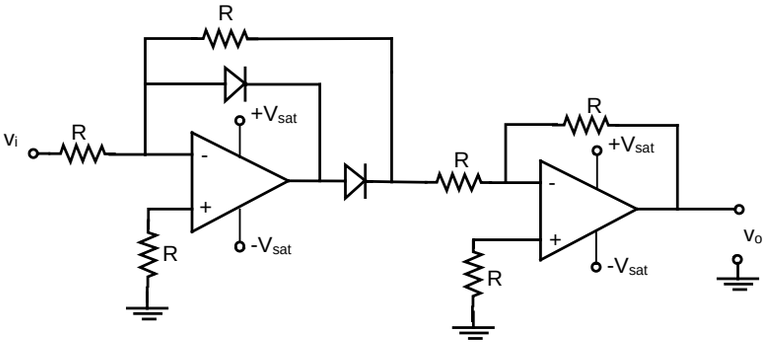


(D)

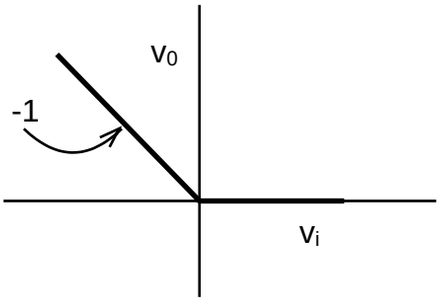


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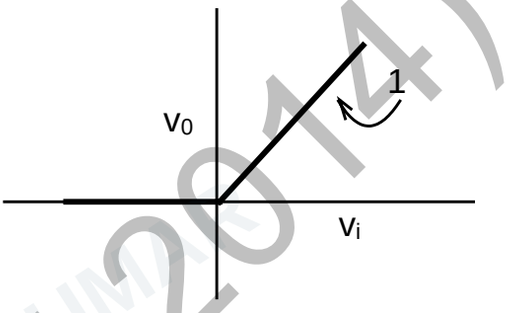
Q.50 The transfer characteristic of the Op-amp circuit shown in figure is



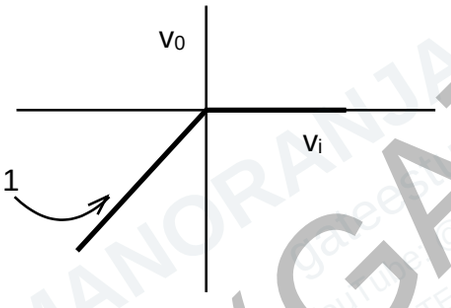
(A)



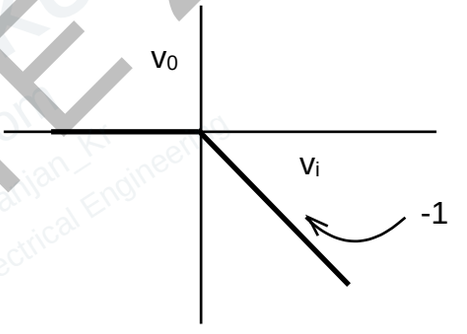
(B)



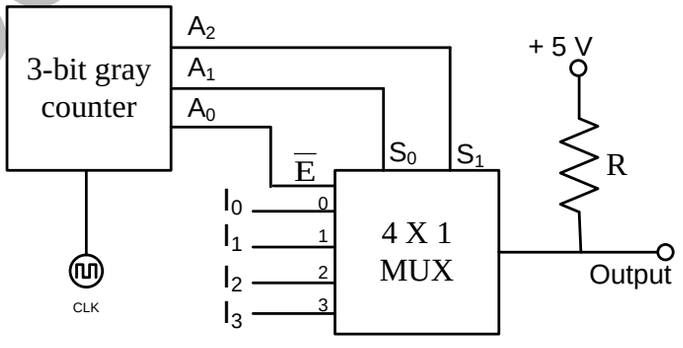
(C)



(D)



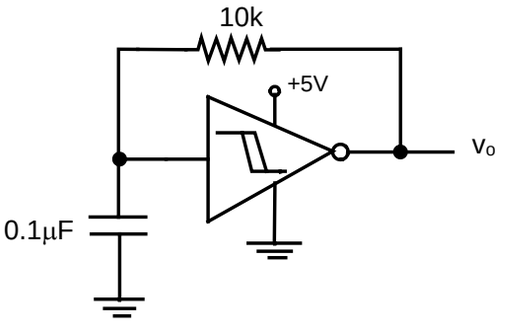
Q.51 A 3-bit gray counter is used to control the output of the multiplexer as shown in the figure. The initial state of the counter is 000_2. The output is pulled high. The output of the circuit follows the sequence



(A) $I_0, 1, 1, I_1, I_3, 1, 1, I_2$
(B) $I_0, 1, I_1, 1, I_2, 1, I_3, 1$
(C) $1, I_0, 1, I_1, I_2, 1, I_3, 1$
(D) $I_0, I_1, I_2, I_3, I_0, I_1, I_2, I_3$

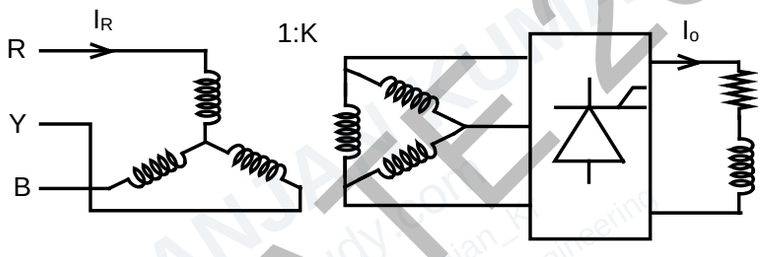
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Q.52 A hysteresis type TTL inverter is used to realize an oscillator in the circuit shown in the figure.



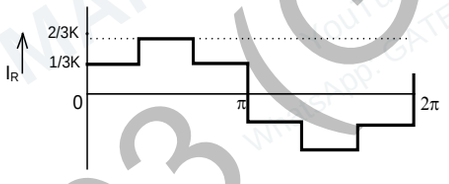
If the lower and upper trigger level voltages are 0.9 V and 1.7 V, the period (in ms), for which output is LOW, is _____.

Q.53 A three-phase fully controlled bridge converter is fed through star-delta transformer as shown in the figure.

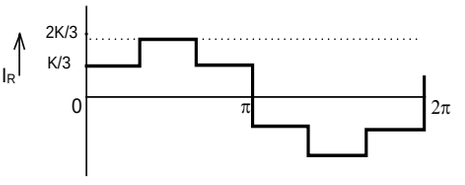


The converter is operated at a firing angle of 30^0. Assuming the load current (I_0) to be virtually constant at 1 p.u. and transformer to be an ideal one, the input phase current waveform is

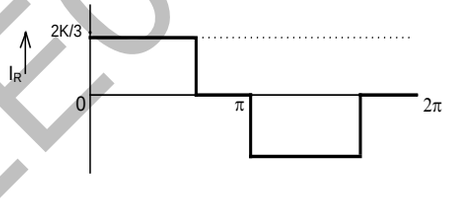
(A)



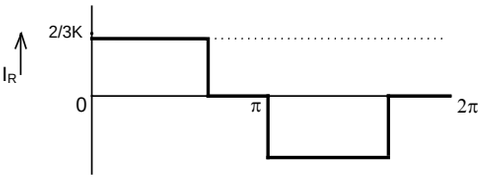
(B)



(C)

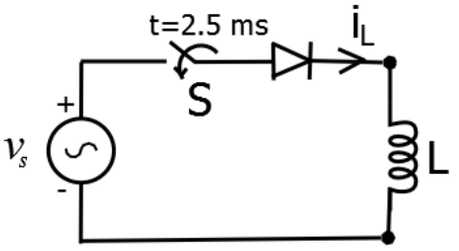


(D)

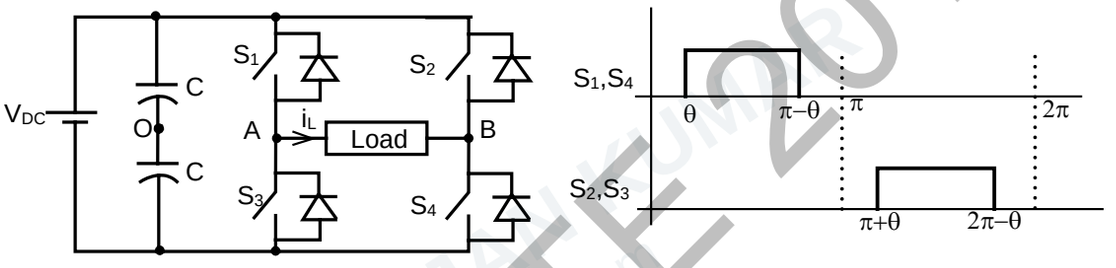


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Q.54 A diode circuit feeds an ideal inductor as shown in the figure. Given $v_s = 100\ \sin(\omega t)$ V, where ω = 100π rad/s, and L = 31.83 mH. The initial value of inductor current is zero. Switch S is closed at t = 2.5 ms. The peak value of inductor current i_L (in A) in the first cycle is _____.

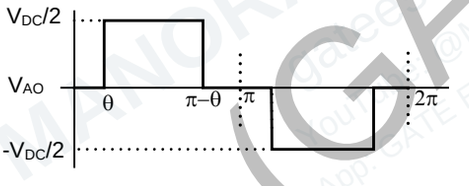


Q.55 A single-phase voltage source inverter shown in figure is feeding power to a load. The triggering pulses of the devices are also shown in the figure.

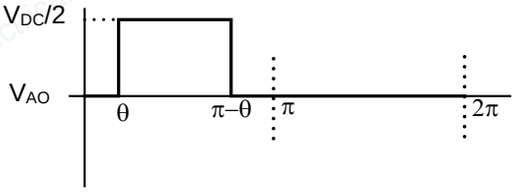


If the load current is sinusoidal and is zero at 0, π, 2π…, the node voltage V_{AO} has the waveform

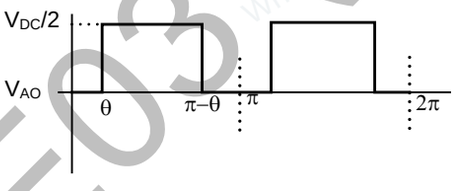
(A)



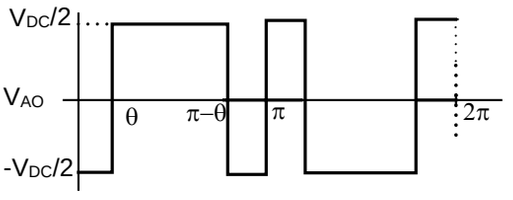
(B)



(C)



(D)



END OF THE QUESTION PAPER

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Answer Keys for EE - Electrical Engineering

Section	Q. No.	SESSION - 3	
		Key / Range	Marks
GA	1	D	1
GA	2	C	1
GA	3	C	1
GA	4	C	1
GA	5	C	1
GA	6	B	2
GA	7	D	2
GA	8	D	2
GA	9	C	2
GA	10	C	2
EE	1	C	1
EE	2	2 to 2	1
EE	3	A	1
EE	4	0.4 to 0.5	1
EE	5	C	1
EE	6	C	1
EE	7	A	1
EE	8	A	1
EE	9	A	1
EE	10	14 to 14	1
EE	11	D	1
EE	12	C	1
EE	13	12.45 to 12.65	1
EE	14	A	1
EE	15	B	1
EE	16	332 to 332	1
EE	17	C	1
EE	18	A	1
EE	19	2 to 2	1
EE	20	A	1
EE	21	D	1
EE	22	D	1
EE	23	C	1

Section	Q. No.	SESSION - 3	
		Key / Range	Marks
EE	24	C	1
EE	25	B	1
EE	26	C	2
EE	27	D	2
EE	28	0.05 to 0.07	2
EE	29	2 to 2	2
EE	30	3 to 3	2
EE	31	B	2
EE	32	B	2
EE	33	D	2
EE	34	C	2
EE	35	B	2
EE	36	B	2
EE	37	32.4 to 34.0	2
EE	38	879 to 881	2
EE	39	23 to 24	2
EE	40	B	2
EE	41	186 to 188	2
EE	42	0.75 to 0.75	2
EE	43	0.22 to 0.24	2
EE	44	B	2
EE	45	A	2
EE	46	C	2
EE	47	A	2
EE	48	0.3 to 0.3	2
EE	49	C	2
EE	50	C	2
EE	51	A	2
EE	52	0.62 to 0.66	2
EE	53	B	2
EE	54	16.6 to 17.4	2
EE	55	D	2

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