GATE 2026 Electrical Engineering Question Paper

General Instructions

(i) This question paper contains 65 questions. All questions are compulsory.

(ii) It comprises 48 single-correct multiple-choice questions, 4 multiple-correct questions and 13 numerical / integer-type questions.

(iii) Attempt every question; detailed solutions are provided in the companion solutions booklet.

(iv) For multiple-correct questions, all correct options must be selected to earn full marks.

(v) For numerical questions, report the answer rounded exactly as asked.

. 'The shopkeeper sells lemons.'
In this sentence, the word 'lemons' is the __________.

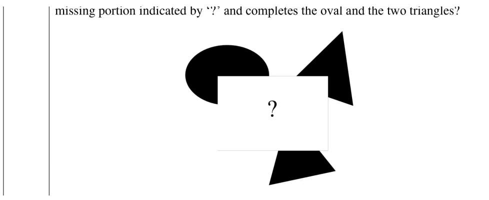
(A) object

(B) subject

(C) predicate

(D) verb

. The figure below is supposed to show three non-overlapping shapes: one oval and two triangles. Which one of the following figures P, Q, R, or S fits the missing portion indicated by '?' and completes the oval and the two triangles?



(A) P

(B) Q

(C) R

(D) S

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. At how many points will the curves $y = x^2$ and $y = -x^2 - 2x - 1$ intersect in the real (x, y) plane?

(A) 0

(B) 1

(C) 2

(D) 3

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. 'If Anish had scored hundred runs in today's match, he would have been made the captain of his team. He would have then become the youngest captain in his team's history. Unfortunately, he got out without scoring any runs. Hence, there won't be any change in the captaincy for now.' Based on the paragraph above, which one of the following statements is true?

(A) Anish made hundred runs but was denied captaincy.

(B) Anish was the captain of his team before the game today.

(C) The current captain is older than Anish.

(D) Anish is the youngest player in his team.

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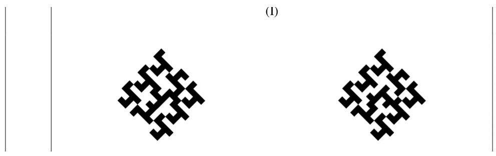
. Which one of the following figures P, Q, R, or S, correctly shows the 45° clockwise-rotated version of figure (I)?



(A) P

(B) Q

(C) R

(D) S

. Match the words in Column I with their synonyms in Column II.

Column I	**Column II**
(i) Lonely	(p) Verbatim
(ii) Literal	(q) Solitary
(iii) Lousy	(r) Deadly
(iv) Lethal	(s) Terrible

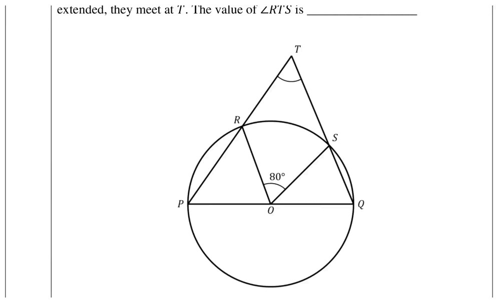
(A) (i)-(q); (ii)-(p); (iii)-(s); (iv)-(r)

(B) (i)-(q); (ii)-(s); (iii)-(r); (iv)-(p)

(C) (i)-(s); (ii)-(p); (iii)-(q); (iv)-(r)

(D) (i)-(r); (ii)-(s); (iii)-(p); (iv)-(q)

. In the given figure, $\overline{PQ}$ is the diameter of a circle with center O. Two points R and S are chosen on the circle such that $\angle ROS = 80°$. When $\overline{PR}$ and $\overline{QS}$ are extended, they meet at T. The value of $\angle RTS$ is __________.



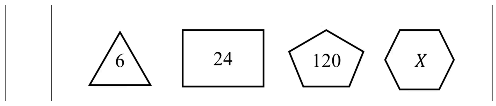
(A) 40°

(B) 50°

(C) 60°

(D) 80°

. Based on the relationship between each polygon and the number inside it, the value of 'X' is ________. A triangle contains the number 6, a rectangle contains 24, a pentagon contains 120, and a hexagon contains X.



(A) 720

(B) 596

(C) 24

(D) 240

. Consider a linear arrangement of seven bulbs, each of which can be in the ON or OFF state. The initial configuration of the bulbs is shown below. In every step, the states of the bulbs change based on the following rules:

- Any OFF bulb with exactly one ON neighbor at the end of the previous step is turned ON.
- Any ON bulb with both neighbors ON at the end of the previous step is turned OFF.
- The state of any bulb not meeting the conditions above is left unchanged.

The states of the bulbs at the end of Step 1 and Step 2 are also shown below.

Stage	Bulb 1	Bulb 2	Bulb 3	Bulb 4	Bulb 5	Bulb 6	Bulb 7
Initial	OFF	OFF	OFF	ON	OFF	OFF	OFF
Step 1	OFF	OFF	ON	ON	ON	OFF	OFF
Step 2	OFF	ON	ON	OFF	ON	ON	OFF

The number of bulbs which are ON at the end of Step 8 is ________

(A) 5

(B) 4

(C) 3

(D) 0

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. P and Q are two positive integers such that $P^2 = Q^2 + 13$.

The product of the numbers P and Q is ____________

(A) 13

(B) 26

(C) 39

(D) 42

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. Consider the infinite-length, discrete-time sequence $x[n] = 0.9^{|n|}$, where n is an integer. The region of convergence of its Z-transform $X(z)$ is given by:
(Note: z is a complex variable)

(A) $|z| > 0.9$

(B) $|z| < 0.9$

(C) $0.9 < |z| < 1/0.9$

(D) $\{z \text{ such that } |z| < 0.9\} \cup \{z \text{ such that } |z| > 1/0.9\}$

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. Let $x_c(t)$ be any continuous-time periodic signal with period T. It is sampled uniformly with a sampling period T_s where $T_s \neq T$, resulting in the discrete sequence

$$x[n] = x_c(nT_s),$$

where n is an integer.

Which one of the following statements is correct about $x[n]$?

(A) $x[n]$ will always be periodic with period T/T_s for all values of T/T_s

(B) $x[n]$ will always be periodic with period 1 for all values of T/T_s

(C) $x[n]$ will never be periodic

(D) $x[n]$ will be periodic if and only if T/T_s is a rational number

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. The Laplace transform of the step response of a system is given by

$$Y(s) = \frac{100}{s(s+100)}$$

The rise time is defined as the time taken for the response to go from 0.1 to 0.9 of its final value. The settling time is defined as the time taken for the response to reach 0.98 of its final value.

For this system, the rise time (T_r), settling time (T_s), and time constant (T_c), all expressed in seconds, are

(A) $T_r = 0.022,\ T_s = 0.04,\ T_c = 0.01$

(B) $T_r = 0.22,\ T_s = 0.404,\ T_c = 0.01$

(C) $T_r = 2.2,\ T_s = 4.04,\ T_c = 1.01$

(D) $T_r = 22,\ T_s = 40.4,\ T_c = 10.1$

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. Consider the following differential equation:

$$t^2 \frac{d^2y}{dt^2} + 7t\frac{dy}{dt} + 8ty = 10\sin(t)$$

Which one of the following options is correct?

(A) It is a linear differential equation

(B) It is a nonlinear differential equation

(C) It is a time-invariant differential equation

(D) It is a second-order partial differential equation

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. A uniform ring charge of radius R carries a total charge Q. Which one of the following options correctly quantifies the magnitude of the force on a point charge of strength q kept at the center of the ring?
(ϵ is the permittivity of the medium)

(A) $\dfrac{Qq}{4\pi\epsilon R}$

(B) $\dfrac{Qq}{4\pi\epsilon R^2}$

(C) 0

(D) $\dfrac{q}{4\pi\epsilon R} \times \dfrac{Q}{2\pi R}$

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. A positive point charge with velocity $\vec{v} = 5\hat{x}$ enters a region having electric field $\vec{E} = 4\hat{y}$ and magnetic field $\vec{B} = -6\hat{z}$. Which one of the following statements is correct for the force on the charge as it enters the region?

(A) The force will be along the magnetic field but perpendicular to the electric field

(B) The force will be along the electric field but perpendicular to the magnetic field

(C) The force will be perpendicular to both electric and magnetic field

(D) The magnetic field does not exert any force on the charge

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. A 15 kVA, 1100 V/220 V, single-phase two-winding transformer is configured as a 1.32 kV/1.1 kV autotransformer.

What will be the rating of the autotransformer?

(A) 60 kVA

(B) 75 kVA

(C) 90 kVA

(D) 100 kVA

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. Consider a power system with N buses, of which P are generator buses and the remaining Q are load buses (where there is no generation).

Assume that there are no reactive power-limit violations at the generator buses.
What is the size of the Jacobian matrix in the Newton-Raphson load flow method?

(A) $2N \times 2N$

(B) $(2N - 1 - P) \times (2N - 1 - P)$

(C) $(2N - Q) \times (2N - Q)$

(D) $(P + Q) \times (P + Q)$

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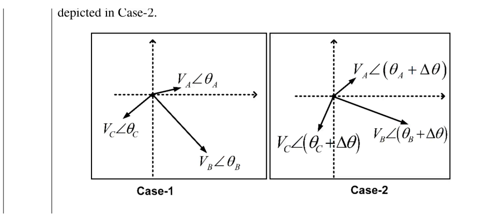
. The initial three-phase voltage phasors ($\bar{V}_A$, $\bar{V}_B$, and $\bar{V}_C$) at a bus of a power network are as shown in Case-1. Due to a disturbance, the bus voltage phasors changed in phase by a small angle $\Delta\theta$, and the magnitudes remained the same as depicted in Case-2.



Which one of the following statements is correct about the zero sequence components?

(A) The zero sequence components in Case-1 and Case-2 have the same phase angle and magnitude

(B) The magnitude of the zero sequence component in Case-1 is greater than that in Case-2

(C) The magnitude of the zero sequence component in Case-2 is greater than that in Case-1

(D) The zero sequence components in Case-1 and Case-2 have the same magnitude but different phase angles

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. A certain application requires power at a frequency of 16.67 Hz, while the available grid frequency is 50 Hz. A 3-phase synchronous motor connected to the 50 Hz, 3-phase grid, driving a synchronous generator, is used for this application.

Which one of the following combinations is a suitable choice for the number of poles in the motor and generator, respectively?

(A) 2, 6

(B) 6, 2

(C) 4, 6

(D) 6, 4

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. Which one of the following options is correct regarding the typical double-squirrel-cage structure used in induction motors?

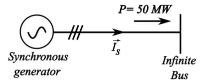
(A) At starting, a larger portion of the rotor current flows in the outer cage

(B) At starting, a larger portion of the rotor current flows in the inner cage

(C) At rated speed, most of the rotor current flows in the outer cage

(D) The purpose of the double-squirrel-cage structure is to lower the effective rotor resistance at starting

. The figure shows the single-line diagram of a synchronous generator delivering $P = 50$ MW of power at unity power factor to an infinite bus.



I_S denotes the stator current phasor. If the field excitation is increased, which one of the following options correctly describes its effect on the stator current, power factor, and load angle of the machine?

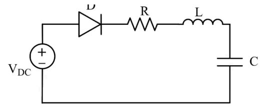
(A) Stator current increases, power factor becomes lagging, load angle remains the same

(B) Stator current decreases, power factor becomes leading, load angle remains the same

(C) Stator current increases, power factor becomes lagging, load angle decreases

(D) Stator current increases, power factor becomes leading, load angle increases

. A circuit with ideal elements is shown.



The circuit has a DC source V_{DC} in series with an ideal diode D, a resistor R, an inductor L, and a capacitor C (the capacitor is connected across the series combination of L at the far end of the loop).
Which one of the following options correctly identifies all the linear elements in the circuit?

(A) R only

(B) R, L, and C only

(C) D only

(D) L, C, and D only

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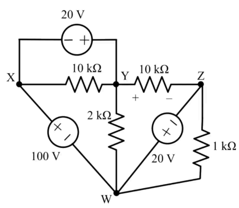
. For the circuit shown, which one of the following options correctly identifies the Thevenin's equivalent parameters between nodes Y and Z?



The circuit has nodes X, Y, Z, and W. Between X and Y there is a 20 V ideal source (in parallel with a 10 kΩ resistor directly connecting X and Y). Between Y and Z there is a 10 kΩ resistor. Between Y and W there is a 2 k Ω resistor. Between X and W there is an ideal 100 V source (no series resistor in this branch). Between Z and W there is an ideal 20 V source (no series resistor in this branch) and, separately, a 1 kΩ resistor.

(A) V_{TH} = 100 V, R_{TH} = 10 kΩ

(B) V_{TH} = 140 V, R_{TH} = 0 Ω

(C) V_{TH} = 100 V, R_{TH} = 0 Ω

(D) V_{TH} = 140 V, R_{TH} = 10 kΩ

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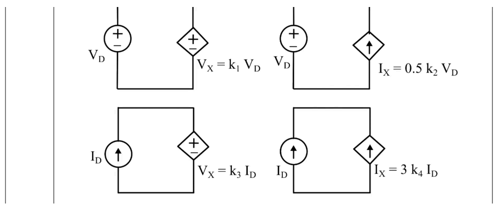
. Refer to the four circuits shown.



Which one of the following options for k_1, k_2, k_3, and k_4 makes all of them realizable?

(A) $k_1 = 1, k_4 = -\frac{1}{3}$, for all values of k_2 and k_3

(B) $k_2 = -2, k_3 = +\frac{1}{3}$, for all values of k_1 and k_4

(C) $k_1 = 2, k_2 = 0.5, k_3 = -\frac{2}{3}, k_4 = -3$

(D) $k_1 = 2, k_2 = -0.5, k_3 = -\frac{2}{3}, k_4 = +3$

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. A single-phase voltage source $v_s = 325\sin(2\pi 50t)$ V delivers a current, $i = 12\sin(2\pi 50t) + 9\sin(2\pi 150t)$ A to a load.

The load power factor, correct up to two decimal places, is:

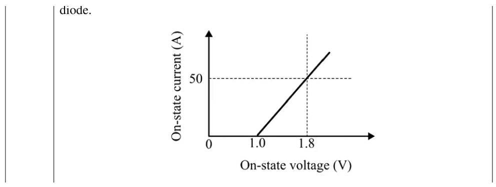
(A) 1.00

(B) 0.80

(C) 0.65

(D) 0.57

. The figure shows a straight-line approximation for the forward characteristics of a power diode. A continuous on-state current of 15 A is flowing through the diode.



What is the power loss in the diode?

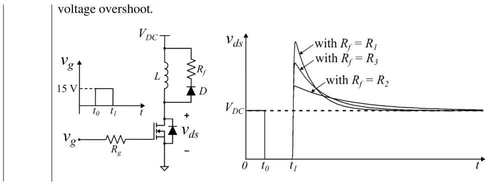
(A) 32.8 W

(B) 21.2 W

(C) 18.6 W

(D) 23.1 W

. Consider the circuit shown in Figure (a). A gate pulse v_g is applied between time instants t_0 and t_1. After t_1, during the MOSFET turn OFF process, it experiences a voltage overshoot.



Based on the v_{ds} waveforms shown in Figure (b), which one of the following options is correct?

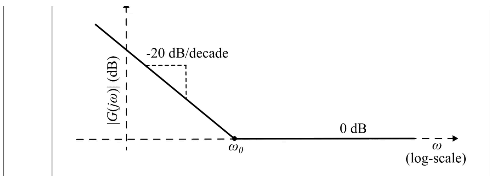
(A) $R_1 > R_2 > R_3$

(B) $R_1 > R_3 > R_2$

(C) $R_3 > R_2 > R_1$

(D) $R_2 > R_3 > R_1$

. The asymptotic Bode magnitude plot of a system is shown.



Which one of the following options best represents the transfer function of the system?

(A) $G(s) = \dfrac{1 + \dfrac{s}{\omega_0}}{\dfrac{s}{\omega_0}}$

(B) $G(s) = \dfrac{\dfrac{s}{\omega_0}}{1 + \dfrac{s}{\omega_0}}$

(C) $G(s) = \dfrac{1 + \dfrac{s}{\omega_0}}{1 - \dfrac{s}{\omega_0}}$

(D) $G(s) = \dfrac{1 - \dfrac{s}{\omega_0}}{1 + \dfrac{s}{\omega_0}}$

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. Two $n \times n$ matrices A and B have a common eigenvalue 2, and the same corresponding nonzero eigenvector.

Which of the following options is/are correct?

(Note: I is the $n \times n$ identity matrix.)

(A) Determinant $(A - 2I) = 0$

(B) Determinant $(B - 2I) = 0$

(C) Determinant $(A + B - 2I) = 0$

(D) Determinant $(A + B - 4I) = 0$

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. A 220V/12V single-phase transformer is designed for use in India and rated 100 VA at 50 Hz. Later, this unit is shipped to the USA where it is used as a 110V/6V transformer at 60 Hz.

Which of the following statements is/are correct?

(A) No-load current drawn would be smaller for operation in the USA compared to that in India

(B) For the same load current, the losses would be higher in the USA compared to that in India

(C) The peak magnetic flux density in the core would be higher while operating in the USA compared to that in India

(D) The eddy current losses in the core would be approximately 44% higher while operating in the USA compared to that in India

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. Given that $\vec{F}(x, y, z) = \sin(y)\,\hat{x} + \cos(x)\,\hat{y} + 5\,\hat{z}$, the integral $\oiint_S \vec{F}(x, y, z) \cdot d\vec{s}$ over the unit sphere S centered at the origin evaluates to

(Round off to one decimal place)

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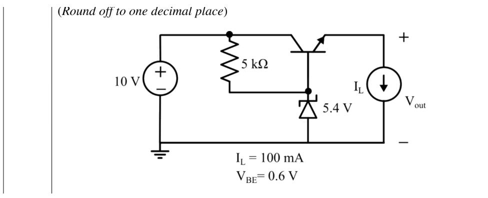
. In the linear regulator circuit shown, the base to emitter voltage V_{BE} of the BJT is 0.6 V. The Zener diode clamps the base voltage to 5.4 V. Ignore the biasing current of the Zener diode and the BJT.



The input supply is 10 V and the load current is $I_L = 100$ mA. The maximum possible efficiency of the regulator circuit is % (round off to one decimal place).

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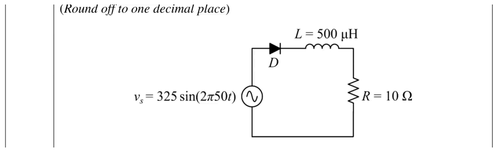
. Consider the circuit shown. Assume that the diode D is ideal. The supply voltage $v_s = 325\sin(2\pi 50t)$ V, $L = 500\ \mu H$, and $R = 10\ \Omega$.



The peak diode current (in amperes) is (round off to one decimal place).

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. A is an $m \times m$ skew-symmetric matrix with real-valued entries, and x is an m-dimensional column vector with real-valued entries such that $x^T x = 1$. The quantity $x^T A x$ evaluates to (answer in integer).

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. A time-limited waveform $g(x)$ is specified as follows:

$$g(x) = \begin{cases} -k, & -\pi < x \leq 0 \\ +k, & 0 < x \leq \pi \\ 0, & \text{otherwise} \end{cases}$$

A new waveform $f(x)$ is constructed from $g(x)$ as follows:

$$f(x) = \sum_{m=-\infty}^{\infty} g(x + 2\pi m), \qquad \text{for all } x \in \mathbb{R}$$

The sum of the coefficients of the third harmonics of the sine and cosine terms in the trigonometric Fourier series expansion of $f(x)$ is $\frac{2}{3\pi}$. What is the value of k?

(A) 1

(B) $\frac{1}{2}$

(C) $\frac{1}{3}$

(D) $\frac{1}{4}$

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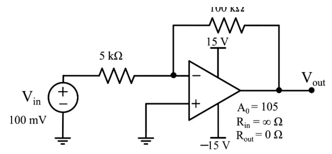
. In the circuit shown, the open loop gain of the operational amplifier is $A_0 = 105$, with $R_{in} = \infty\ \Omega$ and $R_{out} = 0\ \Omega$.



The circuit is a standard inverting amplifier: $V_{in} = 100$ mV drives the inverting input through a 5 $k\Omega$ input resistor, and a 100 $k\Omega$ resistor feeds back from V_{out} to the inverting input, with the non-inverting input grounded. What is the voltage gain of the circuit? (Round off to two decimal places)

(A) -16.67

(B) -20.00

(C) -21.00

(D) -12.67

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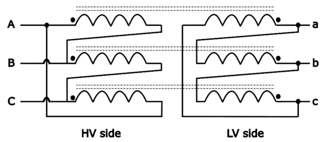
. Three single-phase 11kV/3.3kV transformers are connected to form a three-phase transformer bank, with the HV and LV windings connected as shown.



Considering **ABC** phase sequence, the vector group of the transformer is:

(A) Dd0

(B) Dd4

(C) Dd6

(D) Dd10

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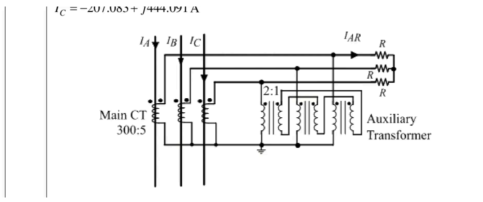
. In the circuit shown, the phase currents are

$$I_A = 572.812 + j50.115 \text{ A}$$

$$I_B = -254.525 - j459.175 \text{ A}$$

$$I_C = -207.083 + j444.091 \text{ A}$$



Given that the CTs are ideal with no saturation, and the turns ratio of the Main CT is $300:5$ and that of the Auxiliary Transformer ($Yn\Delta$) is $2:1$ on every phase, the value of I_{AR}, rounded off to three decimal places, is:

(A) 0 A

(B) $0.653\angle 17.556°$ A

(C) $537.240\angle 4.105°$ A

(D) $8.954\angle 4.105°$ A

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. The operating characteristic of a reactance relay is given by $X \leq 1\ \Omega$, where X is the reactance calculated by the relay. Its operating characteristic in the admittance plane (G-B plane, where G and B denote conductance and susceptance, respectively, expressed in Ω^{-1}) is given by:

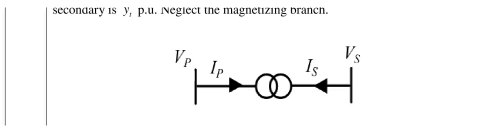
(A) $G^2 + (B + 0.5)^2 \geq \frac{1}{4}$

(B) $B \geq 1$

(C) $(G - 1)^2 + B^2 \leq \frac{1}{2}$

(D) $G^2 + (B - 1)^2 \geq \frac{1}{2}$

. A three-phase two-winding transformer has a voltage transformation ratio $\frac{V_P}{V_S} = 0.866 + j0.5$, where V_P is the primary side voltage in p.u., and V_S is the secondary side voltage in p.u. I_P and I_S represent the currents injected into the primary and secondary sides of the transformer, respectively. The admittance corresponding to the leakage impedance of the transformer referred to the secondary is y_t p.u. Neglect the magnetizing branch.



The Y bus representation of this transformer is:

(A)

$$\begin{bmatrix} I_P \\ I_S \end{bmatrix} = \begin{bmatrix} \frac{y_t}{0.866 + j0.5} & -\frac{y_t}{0.866 + j0.5} \\ -\frac{y_t}{0.866 + j0.5} & \frac{y_t}{0.866 + j0.5} \end{bmatrix} \begin{bmatrix} V_P \\ V_S \end{bmatrix}$$

(B)

$$\begin{bmatrix} I_P \\ I_S \end{bmatrix} = \begin{bmatrix} y_t & -y_t \\ -y_t & y_t \end{bmatrix} \begin{bmatrix} V_P \\ V_S \end{bmatrix}$$

(C)

$$\begin{bmatrix} I_P \\ I_S \end{bmatrix} = \begin{bmatrix} y_t & -\frac{y_t}{0.866 + j0.5} \\ -\frac{y_t}{0.866 + j0.5} & y_t \end{bmatrix} \begin{bmatrix} V_P \\ V_S \end{bmatrix}$$

(D)

$$\begin{bmatrix} I_P \\ I_S \end{bmatrix} = \begin{bmatrix} y_t & -\frac{y_t}{0.866 - j0.5} \\ -\frac{y_t}{0.866 + j0.5} & y_t \end{bmatrix} \begin{bmatrix} V_P \\ V_S \end{bmatrix}$$

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. An electrical component has voltage drop $\upsilon = V_m \sin(\omega t)$, when the current through it is $i = I_m \sin(\omega t - \theta)$.
What is the average power dissipated over a half cycle corresponding to ω?

(A) 0

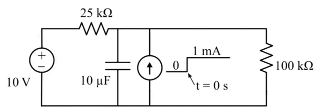
(B) $V_m I_m \cos\theta$

(C) $\frac{V_m I_m}{2} \cos\theta$

(D) $\frac{V_m I_m}{4} \cos\theta$

• • •

. The electrical network shown has an independent voltage source (10 V) and a current source (1 u(t) mA).



The voltage across the capacitor at time instants (in seconds) $t = 0^{+}$, $t = 0.50$, and $t = \infty$, respectively, is:

(A) 8.00 V, 28.00 V, 26.36 V

(B) 8.00 V, 26.36 V, 28.00 V

(C) 10.00 V, 26.36 V, 28.00 V

(D) 10.00 V, 28.00 V, 26.36 V

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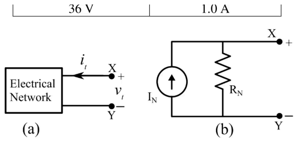
. The terminal voltage and current of a linear electrical network shown in Figure (a) are given in the table.

Terminal voltage (v_t)	**Terminal current (i_t)**
18 V	−0.5 A
30 V	0.5 A
36 V	1.0 A



The correct choice for the parameters (I_N, R_N) of the Norton equivalent circuit shown in Figure (b) is:

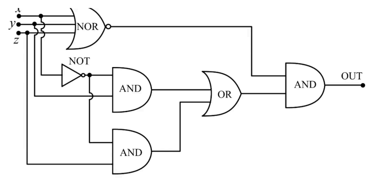
(A) $I_N = 3.0\ \text{A}, R_N = 24.0\ \Omega$

(B) $I_N = 12.0\ \text{A}, R_N = 2.0\ \Omega$

(C) $I_N = 2.0\ \text{A}, R_N = 12.0\ \Omega$

(D) $I_N = 2.0\ \text{A}, R_N = 24.0\ \Omega$

. The digital circuit shown has 3 inputs (x, y, and z).



The simplified logical expression for the output (OUT) is:

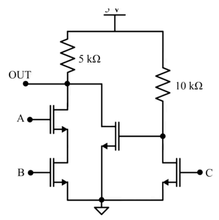
(A) $\bar{x}\,\overline{yz}$

(B) 0

(C) $\bar{x}(y+z)$

(D) 1

. The MOSFET switches shown in the circuit are ideal.



Which of the following is the correct option for Boolean logical expression of the output (OUT), and the maximum possible power (P) consumed by the circuit?

(A) OUT = $\overline{AB + \bar{C}}$, P = 5 mW

(B) OUT = $\overline{(A + B)\bar{C}}$, P = 5 mW

(C) OUT = $\overline{AB\bar{C}} + \bar{C}$, P = 7.5 mW

(D) OUT = $\overline{ABC}$, P = 7.5 mW

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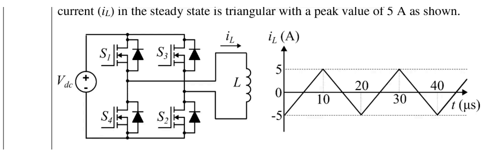
. Consider the single-phase voltage source inverter circuit feeding an inductive load (L). Assume that the power MOSFET switches are ideal. S_1 and S_2 are switched on during the first 10 μs, and S_3 and S_4 are switched on during the next 10 μs in a switching cycle. The switches in the same leg are thus switched in a complementary fashion. Neglect the dead time. The waveform of the inductor current (i_L) in the steady state is triangular with a peak value of 5 A as shown.



The rms value of the current through the switch S_1 is:

(A) 2.88 A

(B) 2.04 A

(C) 3.54 A

(D) 2.50 A

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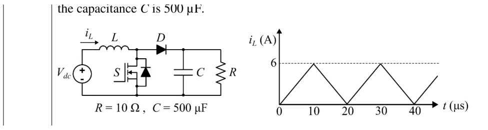
. Consider the boost converter circuit shown. Assume that the semiconductor devices are ideal. In steady state, the inductor current rises linearly from 0 A to 6 A in the first 10 μs and then falls linearly from 6 A to 0 A in the next 10 μs of every switching cycle as shown. The load resistance R is 10 Ω and the capacitance C is 500 μF.



Neglect the ripple in the output voltage. What is the input voltage V_{dc}?

(A) 10.0 V

(B) 15.0 V

(C) 7.5 V

(D) 12.5 V

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. Which one of the following statements is ALWAYS correct about a collection of p column vectors, each having n real-valued entries?

(A) If $p > n$, then the column vectors must be linearly dependent

(B) If $p > n$, then the column vectors must be linearly independent

(C) If $p = n$, then the column vectors must be orthogonal

(D) If $p < n$, then the column vectors must be linearly independent

• • •

. Consider the second-order differential equation

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

with initial conditions

$$y(0) = 1, \qquad \left.\frac{dy}{dx}\right|_{x=0} = 1$$

The solution is given by

(A) $y(x) = \exp(-x/2)\left(\cos\left(\frac{\sqrt{3}\,x}{2}\right) + \sqrt{3}\sin\left(\frac{\sqrt{3}\,x}{2}\right)\right)$

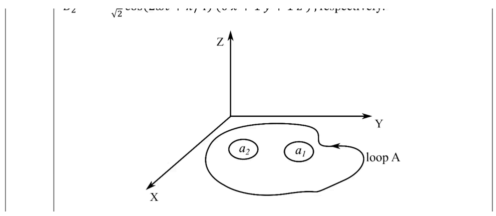
(B) $y(x) = \exp(-x/2)\left(\cos\left(\frac{\sqrt{3}\,x}{2}\right) + \frac{1}{\sqrt{3}}\sin\left(\frac{\sqrt{3}\,x}{2}\right)\right)$

(C) $y(x) = \exp(-x/2)\left(\cos\left(\frac{\sqrt{3}\,x}{2}\right) - \frac{1}{\sqrt{3}}\sin\left(\frac{\sqrt{3}\,x}{2}\right)\right)$

(D) $y(x) = \exp(-x/2)\left(\cos\left(\frac{\sqrt{3}\,x}{2}\right) - \sqrt{3}\sin\left(\frac{\sqrt{3}\,x}{2}\right)\right)$

• • •

. The figure shows an arbitrarily shaped planar conducting loop A in the XY plane. Two nonintersecting regions with areas a_1 and a_2 within the loop are subjected to magnetic fields $\vec{B}_1 = \frac{m}{\sqrt{2}}\sin(\omega t)\left(1\,\hat{x} + 0\,\hat{y} + 1\,\hat{z}\right)$, and $\vec{B}_2 = -\frac{n}{\sqrt{2}}\cos(2\omega t + \pi/4)\left(0\,\hat{x} + 1\,\hat{y} + 1\,\hat{z}\right)$, respectively.



What is the expression for the induced rms voltage in loop A?

(A) $\sqrt{\dfrac{a_1^2\omega^2m^2 + 4a_2^2\omega^2n^2}{4}}$

(B) $\sqrt{\dfrac{a_1^2\omega^2m^2 + 4a_2^2\omega^2n^2}{2}}$

(C) $\sqrt{\dfrac{a_1^2\omega^2m^2 - 2a_2^2\omega^2n^2}{2}}$

(D) $\sqrt{a_1^2\omega^2m^2 + 2a_2^2\omega^2n^2}$

. A system is characterized by the following state equation and output equation (u: input, $\mathbf{x}$: state vector, y: output)

$$\dot{\mathbf{x}} = \begin{bmatrix} a & b \\ -a & 0 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 2 \end{bmatrix} \mathbf{x}$$

What are the values of a and b for which the poles of the transfer function are at $-2 + j3$ and $-2 - j3$?

(A) $a = 4,\ b = 3.25$

(B) $a = -4,\ b = 3.25$

(C) $a = 4,\ b = -3.25$

(D) $a = -4,\ b = -3.25$

• • •

. A system is represented in state-space form as follows (u: input, $\mathbf{x}$: state vector, y: output)

$$\dot{\mathbf{x}} = \begin{bmatrix} 1 & 2 \\ -3 & 0 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 2 \end{bmatrix} \mathbf{x}$$

Consider the new state vector $\mathbf{z} = \begin{bmatrix} 2 & 1 \\ -1 & 0 \end{bmatrix} \mathbf{x}$

What is the state-space representation of the system in terms of the new state vector $\mathbf{z}$?

(A) $\dot{\mathbf{z}} = \begin{bmatrix} -1 & 4 \\ -1 & -2 \end{bmatrix}\mathbf{z} + \begin{bmatrix} 4 \\ -1 \end{bmatrix}u$

$y = [2 \quad 3]\,\mathbf{z}$

(B) $\dot{\mathbf{z}} = \begin{bmatrix} 2 & 3 \\ 0 & 3 \end{bmatrix}\mathbf{z} + \begin{bmatrix} 3 \\ 5 \end{bmatrix}u$

$y = [2 \quad 3]\,\mathbf{z}$

(C) $\dot{\mathbf{z}} = \begin{bmatrix} 4 & 9 \\ -2 & -3 \end{bmatrix}\mathbf{z} + \begin{bmatrix} 4 \\ -1 \end{bmatrix}u$

$y = [2 \quad 3]\,\mathbf{z}$

(D) $\dot{\mathbf{z}} = \begin{bmatrix} 2 & 1 \\ -4 & 1 \end{bmatrix}\mathbf{z} + \begin{bmatrix} 4 \\ -1 \end{bmatrix}u$

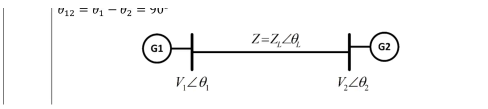
$y = [4 \quad -1]\,\mathbf{z}$

• • •

. For the balanced 3-phase transmission line shown, consider the following cases:

Case-1: $|V_1| = 1.1$ p.u., $|V_2| = 0.9$ p.u., $Z = 0.75\angle 0°$ p.u. and $\theta_{12} = \theta_1 - \theta_2 = 0°$

Case-2: $|V_1| = 1.1$ p.u., $|V_2| = 0.9$ p.u., $Z = 0.75\angle 90°$ p.u. and $\theta_{12} = \theta_1 - \theta_2 = 90°$



Which of the following statements is/are correct about real power loss and reactive power loss in the line?

(A) Real power loss in Case-1 is more than that in Case-2

(B) Real power loss in Case-2 is more than that in Case-1

(C) Reactive power loss in Case-1 is more than that in Case-2

(D) Reactive power loss in Case-2 is more than that in Case-1

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. Consider an $n \times n$ orthogonal matrix A with real entries and each column having unit Euclidean norm.

Which of the following statements is/are correct?

(A) The value of the determinant of A is either $+1$ or -1

(B) The eigenvalues of A have modulus 1

(C) $\|Ax\| = \|x\|$, for all $x \in R^n$, where $\|x\|$ denotes the Euclidean norm of x, and $(Ax)^T(Ay) \neq x^T y$, for all distinct $x, y \in R^n$

(D) $\|Ax\| = \|x\|$, for all $x \in R^n$, where $\|x\|$ denotes the Euclidean norm of x, and $(Ax)^T(Ay) = x^T y$, for all $x, y \in R^n$

• • •

. Consider the system of linear equations $Ax = b$, where A is an $n \times n$ matrix, and x and b are n-dimensional column vectors.

Suppose this system of equations has a unique solution. Which of the following statements is/are correct?

(A) A^{-1} exists

(B) The system of equations $A^m x = b$ also has a unique solution for $m = 1, 2, 3, \ldots$

(C) $\text{rank}(A) = \text{rank}(A^m)$, for $m = 1, 2, 3, \ldots$

(D) $\text{rank}(A) < \text{rank}([A \mid b])$, where $[A \mid b]$ denotes the augmented matrix

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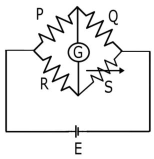
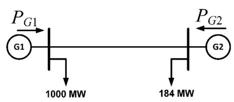
. The resistance values of the Wheatstone bridge shown are $P = 2000\ \Omega$, $Q = 500\ \Omega$, $R = 3000\ \Omega$. The battery voltage is $E = 50$ V.
The battery has an internal resistance of 1 Ω and the Galvanometer (G) has a resistance of 50 Ω.



The value of the resistance S for balanced condition is Ω (Answer in integer)

. A system with two generators G1 and G2 (without generator limits) is shown.



The total load on the system is 1184 MW. The expressions for the cost of generation (C_1 and C_2) and real power loss (P_{Loss}) are as follows:

$$C_1(P_{G1}) = 1000 + 50P_{G1} + 0.01(P_{G1})^2 \text{ Rs/MWh}$$

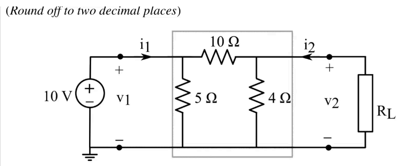
$$C_2(P_{G2}) = 2000 + 50P_{G2} + 0.001(P_{G2})^2 \text{ Rs/MWh}$$

$$P_{Loss} = 0.001(P_{G2} - 50)^2 \text{ MW}$$

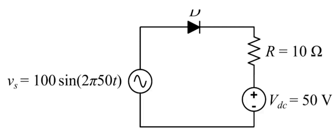
When the generators are operating at their optimal generation, meeting the total load requirement, the real power loss in the system is MW (Round off to one decimal place)
Consider the Lagrange multiplier $\lambda = 70.25$ for optimal generation.

. A balanced three-phase supply is given to a 30 kW, 4-pole, 400 V, 50 Hz, wound rotor induction motor with Y-connected stator and rotor windings. The motor is driving a constant torque load. With shorted sliprings, the machine runs at 1476 rpm.
When an external non-inductive resistance of 0.27 Ω per phase is connected in series in the rotor circuit, the steady-state speed drops to 1404 rpm.
Neglecting rotational losses, the actual per phase rotor winding resistance is Ω (Round off to two decimal places)

. Consider the two-port network shown. For maximum power transfer to the resistive load (R_L), the value of R_L should be Ω
(Round off to two decimal places)



. Consider the circuit shown. Assume that the diode (D) is ideal.



Given $v_s = 100\sin(2\pi 50t)$ V, $V_{dc} = 50$ V, and $R = 10$ Ω, the average value of the current through the diode is A (Round off to two decimal places)

. The magnitude of the contour integral

$$\oint_C \left(\frac{(z+1)^2}{(z-i)(z-2)} \right) dz$$

over the contour $C : |z - 2 - i| = 3/2$ is (round off to two decimal places).
Note: z is a complex variable and $i = \sqrt{-1}$.

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. A uniform spherical volume charge distribution of radius 2 m, centered at the origin, has a strength of $\frac{3}{\pi} \times 10^{-6}$ C/m^3. A point charge of strength $\pi \times 8.854 \times 10^{-12}$ C is moved from $(-3, 0, -4)$ to $(0, 0, 4)$ in Cartesian coordinate system. The relative permittivity of the medium is 1 and the coordinate values are in meters.
The work done during the process is μJ (round off to two decimal places).

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. Let X and Y be two real-valued random variables with $E(X) = 1, E(Y) = 2, E(X^2) = 4, E(Y^2) = 9$, and $E(XY) = 0.9$, where E denotes the expectation operator.
The value of α that minimizes $E((X - \alpha Y)^2)$ is (round off to one decimal place).

• • •

. The integral

$$\frac{1}{\pi} \int_0^\infty \frac{x^{2026}}{(1 + x^{2026})(1 + x^2)} dx$$

evaluates to (round off to two decimal places).