IN INSTRUMENTATION ENGINEERING

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1) Despite his initial hesitation, Rehman's _____ to contribute to the success of the project never wavered.
Select the most appropriate option to complete the sentece.

(GATE IN 2025)

a) ambivalence b) satisfaction c) resolve d) revolve

2) Bird: Nest :: Bee : _____
Select the correct option to complete the analogy.

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a) Kennel b) Hammock c) Hive d) Lair

3) If $Pe^{x} = Qe^{-x}$ for all real values of x, which one of the following statements is true?

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a) $P = Q = 0$
b) $P = Q = 1$
c) $P = 1,\ Q = -1$
d) $\frac{P}{Q} = 0$

4) The paper as shown in Fig. 1 is folded to make a cube where each square corresponds to a particular face of the cube. Which one of the following options correctly represents the cube?

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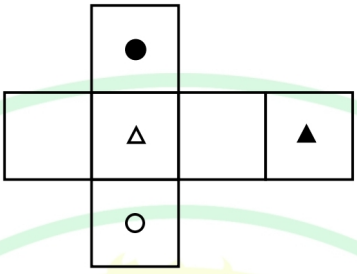
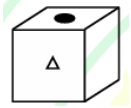


Fig. 1: Outline of Cube

a)



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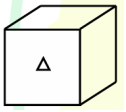
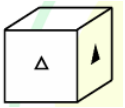
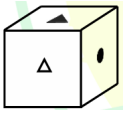


b)





5) Let p_1 and p_2 denote two arbitrary prime numbers. Which one of the following statements is correct for all values of p_1 and p_2?

(GATE IN 2025)

a) $p_1 + p_2$ is not a prime number.
b) $p_1 p_2$ is not a prime number.
c) $p_1 + p_2 + 1$ is a prime number.
d) $p_1 p_2 + 1$ is a prime number.

6) Based only on the conversation below, identify the logically correct inference:

"Even if I had known that you were in the hospital, I would not have gone there to see you", Ramya told Josephine.

(GATE IN 2025)

a) Ramya knew that Josephine was in the hospital.
b) Ramya did not know that Josephine was in the hospital.
c) Ramya and Josephine were once close friends; but now, they are not.
d) Josephine was in the hospital due to an injury to her leg.

7) If IMAGE and FIELD are coded as FHBNJ and EMFJG respectively, then which one among the given options is the most appropriate code for BEACH?

(GATE IN 2025)

a) CEADP
b) IDBFC
c) JGIBC
d) IBCEC

8) Which one of the following options is correct for the given data in the table?

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Iteration (i)	0	1	2	3
Input (I)	20	−4	10	15
Output (X)	20	16	26	41
Output (Y)	20	−80	−800	−12000

a) $X(i) = X(i-1) + I(i);\ Y(i) = Y(i-1)\, I(i),\ i > 0$
b) $X(i) = X(i-1)\, I(i);\ Y(i) = Y(i-1) + I(i),\ i > 0$
c) $X(i) = X(i-1)\, I(i);\ Y(i) = Y(i-1)\, I(i),\ i > 0$
d) $X(i) = X(i-1) + I(i);\ Y(i) = Y(i-1)\, I(i-1),\ i > 0$

9) In Fig. 2, PQRS is a square of side 2 cm and PLMN is a rectangle. The corner L is on QR. Side MN passes through S. Find the area of PLMN.
Note: the figure is representative.

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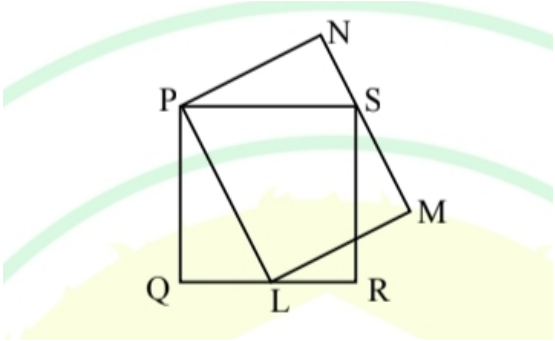

Fig. 2: Diagram for Question-9

a) $2\sqrt{2}$ b) 2 c) 8 d) 4

10) Fig. 3 shows a river system with 7 segments P, Q, R, S, T, U, and V. It splits the land into 5 land zones, marked Z1, Z2, Z3, Z4, and Z5.We need to connect these zones using the least number of bridges. Out of the followinn options, which one is correct?
Note: THe figure shown is representative.

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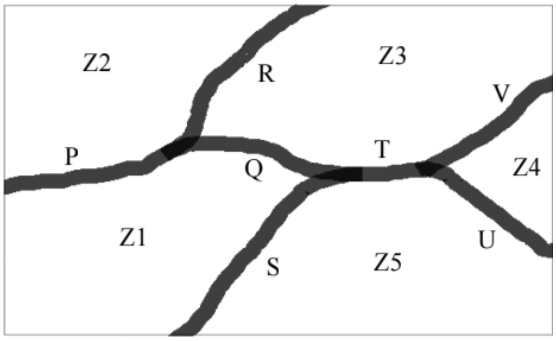

Fig. 3: Division into Zones

a) Bridges on P, Q, and T
b) Bridges on P, Q, S, and T
c) Bridges on Q, R, T, and V
d) Bridges on P, Q, S, U, and V

11) A $2n \times 2n$ matrix $A = \left(a_{ij}\right)$ has

$$a_{ij} = \begin{cases} \beta & if\,(i+j)\,\text{is odd}, \\ -\beta & if\,(i+j)\,\text{is even}, \end{cases}$$

where n is any integer greater than 2 and β is any non-zero real number. Rank of A is

(GATE IN 2025)

a) 1
b) 2
c) n
d) $2n$

12) The solution of $\frac{dy}{dx} = 9\frac{x}{y}$ represents

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a) a hyperbola
b) a parabola
c) an ellipse
d) a circle

13) The working principle of a hand-held metal detector most widely used by security personnel for human frisking is based on the principle of

(GATE IN 2025)

a) change in reluctance of iron core in presence of a metallic object
b) change in conductance of iron core in presence of a metallic object
c) electric field induced by a metallic object
d) eddy current generation in a metallic object

14) The primary coil of a linear variable differential transformer (LVDT) is supplied with AC voltage as shown in Fig. 4. The secondary coils are connected in series opposition and the output is measured using a true RMS voltmeter. The displacement x of the core is indicated in mm on a linear scale.

At the null position $x = 0$, the voltmeter reads $0\,V$. If the voltmeter reads $0.2\,V$ for a displacement of $x = +2\,\text{mm}$, then for a displacement of $x = -3\,\text{mm}$, the voltmeter reading, in V, is

(GATE IN 2025)

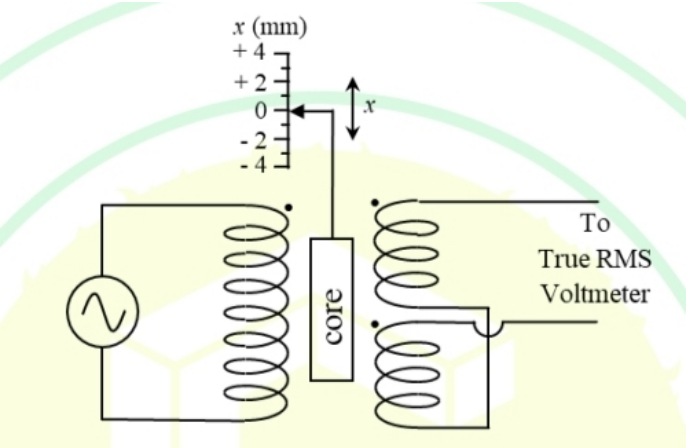

Fig. 4: Linear Variable Differential Transformer

a) -0.3
b) -0.1
c) 0.3
d) 0.5

15) In the force transducer shown in Fig. 5a, four identical strain gauges S_1, S_2, S_3, and S_4 are mounted on a cantilever at equal distance from its base. S_1 and S_2 are mounted on the top surface and S_3 and S_4 are mounted on the bottom surface. These strain gauges are to be connected to form a Wheatstone bridge consisting of arms A, B, C, D, as shown in Fig. 5b. From the following options, the correct order to maximize the measurement sensitivity is

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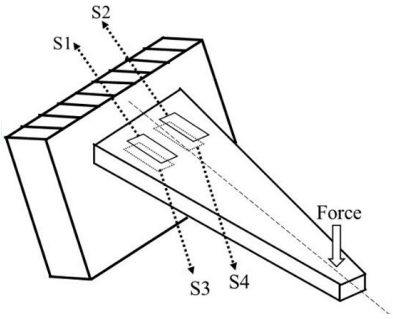
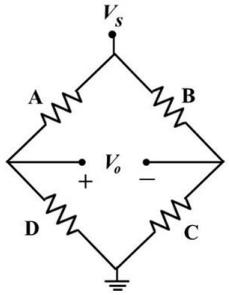


(a) Force Transducer



(b) Wheatstone Bridge

Fig. 5: Diagrams for Question-15

a) A$\rightarrow S_1$, B$\rightarrow S_2$, C$\rightarrow S_4$, D$\rightarrow S_3$
b) A$\rightarrow S_1$, B$\rightarrow S_4$, C$\rightarrow S_3$, D$\rightarrow S_2$
c) A$\rightarrow S_1$, B$\rightarrow S_2$, C$\rightarrow S_3$, D$\rightarrow S_4$
d) A$\rightarrow S_1$, B$\rightarrow S_4$, C$\rightarrow S_2$, D$\rightarrow S_3$

16) Let a continuous-time signal be $x(t) = e^{j9t} + e^{j5t}$, where $j = \sqrt{-1}$ and t is in seconds. The fundamental period of magnitude of $x(t)$, in seconds, is

(GATE IN 2025)

a) π b) $\frac{\pi}{2}$ c) $\frac{\pi}{5}$ d) $\frac{\pi}{9}$

17) The minimized expression of the Boolean function $Y(P, Q, R)$ implemented by the multiplexer (MUX) circuit shown in Fig. 6 is

(GATE IN 2025)

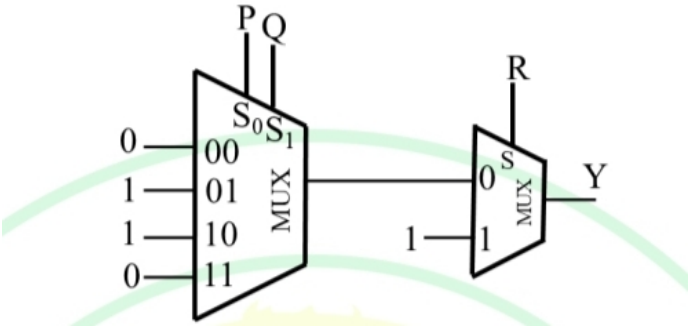


Fig. 6: Multiplexer

a) $Y = R + (P \oplus Q)$
b) $Y = R(P \oplus Q)$
c) $Y = R + \overline{(P \oplus Q)}$
d) $Y = R \oplus (P \oplus Q)$

18) The 4-bit signed 2's complement form of $(5)_{10} + (5)_{10}$ is

(GATE IN 2025)

a) $(-6)_{10}$ b) $(-7)_{10}$ c) $(-5)_{10}$ d) $(-8)_{10}$

19) An infinite sheet of uniform charge $\rho_s = 10\,C/m^2$ is placed on $z = 0$ plane. The medium surrounding the sheet has a relative permittivity of 10. The electric flux density, in C/m^2, at a point $P(0, 0, 5)$ is Note: $\hat{a}$, $\hat{b}$ and $\hat{c}$ are unit vectors along the x, y, and z directions respectively.

(GATE IN 2025)

a) $5\,\hat{c}$ b) $0.25\,\hat{c}$ c) $10\,\hat{c}$ d) $0.5\,\hat{c}$

20) For the ideal opamp based circuit shown in Fig. 7, the ratio $\frac{V}{I}$ is

(GATE IN 2025)

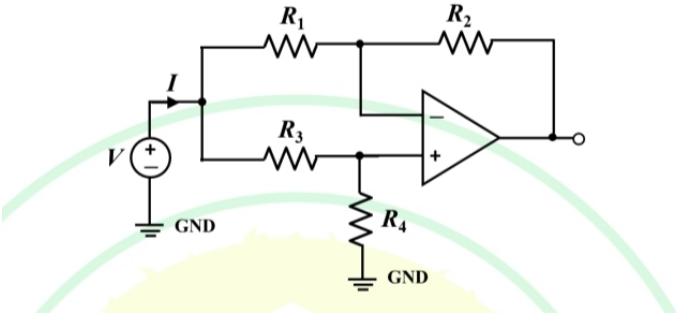


Fig. 7: Circuit Diagram for Question-20

a) $\left(\frac{R_3+R_4}{R_1+R_3}\right)R_1$ b) $\left(\frac{R_2+R_4}{R_3+R_1}\right)R_3$ c) $R_1 + R_3$ d) $R_3 + R_4$

21) In a single-phase AC circuit, the power consumed by load resistance R_L for an excitation V_s is measured using a wattmeter. The same wattmeter is connected in two different topologies, Topology-A and Topology-B, as shown in Fig. 8. Different branch currents and voltage drops are also marked

in the figure.Among the following options, the condition that ensures low error in the wattmeter reading for both is

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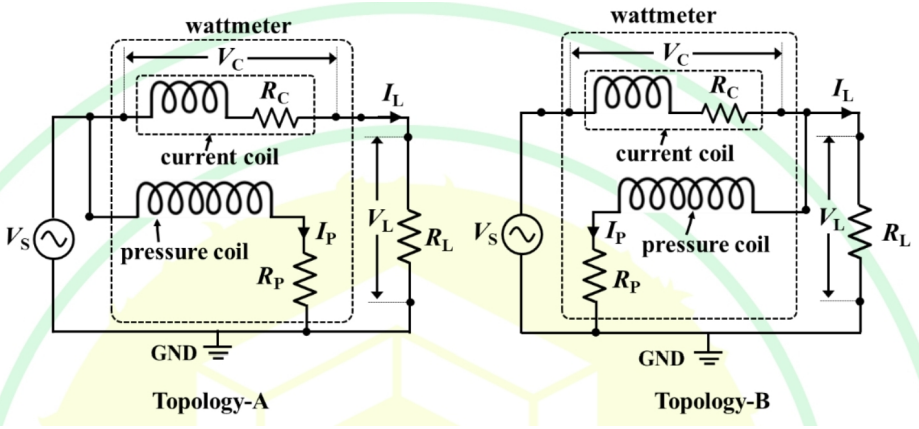

Fig. 8: Topologies A and B

a) $V_L \gg V_c$ for Topology-A and $I_L \gg I_P$ for Topology-B
b) $V_L \gg V_c$ for Topology-A and $I_L \ll I_P$ for Topology-B
c) $V_L \ll V_c$ for Topology-A and $I_L \ll I_P$ for Topology-B
d) $V_L \ll V_c$ for Topology-A and $I_L \approx I_P$ for Topology-B

22) Match the following sensors with their applications:

Sensor	**Application**
(P) Rotary Variable Differential Transformer	(I) Vacuum measurement
(Q) Thermocouple	(II) Force Measurement
(R) Ionisation Gauge	(III) Angular Displacement Measurement
(S) Strain Gauge	(IV) Temperature Measurement

(GATE IN 2025)

a) P-II, Q-III, R-I, S-IV
b) P-II, Q-IV, R-III, S-I
c) P-III, Q-IV, R-II, S-I
d) P-III, Q-IV, R-I, S-II

23) A $3\frac{1}{2}$ digit digital voltmeter has accuracy $\pm(0.5\% + 1)$. If used to measure $10\,V$ DC, the error in the measurement would be
Note: Accuracy of the digital voltmeter is expressed as ±(%of reading + digit).

a) ±0.4% b) ±1.5% c) ±0.6% d) ±1%

24) The circuit shown in Fig. 9a can be represented using its T-model shown in Fig. 9b. The values of the inductances L_1, L_2 and L_3. in equivalent T-model are

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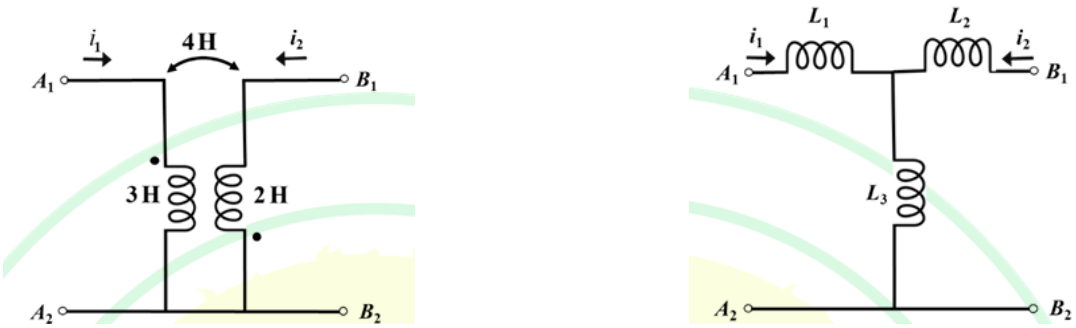

(a) Given Circuit (b) T-model of given circuit

Fig. 9: Diagrams for Question-24

a) $L_1 = 7H,\ L_2 = 6H,\ L_3 = -4H$
b) $L_1 = -1H,\ L_2 = -2H,\ L_3 = 4H$
c) $L_1 = 3H,\ L_2 = 2H,\ L_3 = 9H$
d) $L_1 = 1H,\ L_2 = -2H,\ L_3 = -4H$

25) Three parallel admittances $Y_a = -j0.2\,S$, $Y_b = 0.3\,S$, and $Y_c = j0.4\,S$ connected in parallel with a voltage source $V = 10\angle 45°$ V, draw a total current I_s from the source. The currents flowing through each of these admittances are I_a, I_b and I_c, respectively. Let $I = I_a + I_b$. The phase relation between I and I_s is

(GATE IN 2025)

a) I leads I_s by 19.44°
b) I lags I_s by 19.44°
c) I leads I_s by 33.69°
d) I lags I_s by 33.69°

26) An oscilloscope has an input resistance of $1\,M\Omega$. A $10X$ passive attenuating probe is connected to it. The effective input resistance, in $M\Omega$, seen into the probe tip is

(GATE IN 2025)

a) 0.9 b) 9.1 c) 10 d) 11

27) For the transfer function

$$G(=)\frac{2s-1}{s^3+5s^2+3s+22}$$

the number of zeros lying in the left half s-plane is

(GATE IN 2025)

a) 0 b) 1 c) 2 d) 3

28) Consider the control system block diagram. The loop transfer $G(s)H(s)$ does not have any pole on the $j\omega$-axis. The counterclockwise contour with infinite radius, as shown in Fig. 10b encircles two poles of $G(s)H(s)$. The correct condition for closed-loop stability is

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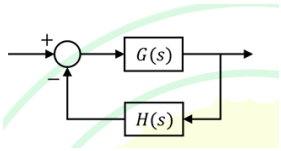
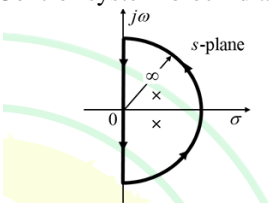


(a) Control system block diagram



(b) Poles encircled by the contour

Fig. 10: Diagrams for Question-28

a) The locus of $G(s)H(s)$ should encircle the origin twice in counter-clockwise direction
b) The locus of $1 + G(s)H(s)$ should encircle the origin twice in clockwise direction
c) The locus of $G(s)H(s)$ should encircle the $-1 + j0$ point twice in counter-clockwise direction
d) The locus of $1 + G(s)H(s)$ should encircle the $-1 + j0$ point twice clockwise direction.

29) A Boolean function X is given as $X = \bar{A}\bar{B} + \bar{A}\bar{C}$. The reduced form of $\bar{X}$ is

(GATE IN 2025)

a) $\bar{A} + \bar{B} + \bar{C}$ b) $A + BC$ c) $\bar{A} + \bar{B} + C$ d) $B + AC$

30) A 60 V DC source with internal resistance $R_{int} = 0.5\Omega$ is connected through a switch to a pair of infinitely long rails separated by $l = 1$ m as shown in Fig. 11. THe rails are placed in a constant uniform magnetic field of flux density $B = 0.5$ T directed into the page. A conducting bar placed on rails moves freely. At the instant of closing the switch, the force induced on the bar is
Note: Assume there is no friction between the bar and the rails. The resistances of the conducting bar and the rails are zero.

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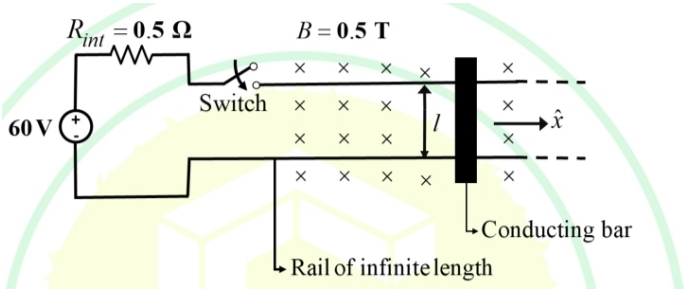


Fig. 11: Diagram for Question-30

a) 60 N in the direction of $\hat{x}$
b) 60 N opposite to the direction of $\hat{x}$
c) 120 N in the direction of $\hat{x}$
d) 120 N opposite to the direction of $\hat{x}$

31) The circuits mentioned below are realized using ideal opamp. Among these, the circuit(s) performing non-linear operation on the input signal is/are

(GATE IN 2025)

a) Instrumentation amplifier
b) Schmitt trigger
c) Logarithmic amplifier
d) Precision rectifier

32) If one of the eigenvectors of the matrix $A = \begin{pmatrix} -1 & -1 \\ x & -4 \end{pmatrix}$ is along direction of $\begin{pmatrix} \alpha \\ 2\alpha \end{pmatrix}$, where α is any non-zero real number, then the value of x is _____.(integer)

(GATE IN 2025)

33) Consider the function $f(z) = \frac{2z+1}{z^2-z}$, where z is a complex variable. The sum of the residues at singular points of $f(z)$ is _____. (integer)

(GATE IN 2025)

34) A dual-slope ADC has fixed integration time of 100 ms. The reference voltage is −5 V. The time taken by the ADC to measure input 1.25 V is _____ ms. (rounded off to the nearest integer)

(GATE IN 2025)

35) In the circuit shown in Fig. 12, assume BJT in the circuit has very high β and $V_{BE} = 0.7$ V. The Zener diode has $V_z = 4.7$ V. The current I through the LED is _____ mA.

(GATE IN 2025)

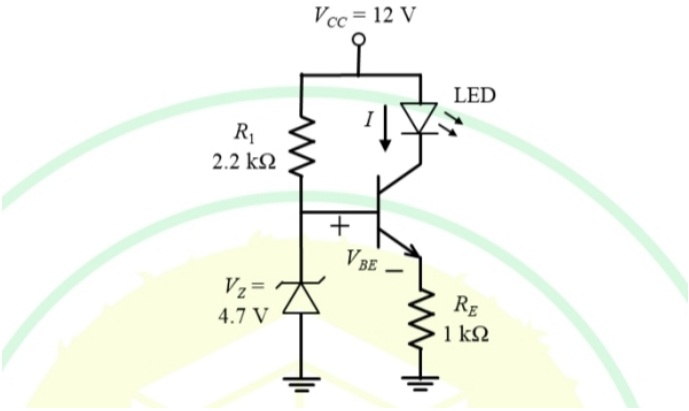


Fig. 12: Circuit Diagram for Question-35

36) The value of the surface integral

$$\iint_S (2x + z)\, dy\, dz + (2x + z)\, dx\, dz + (2z + y)\, dx\, dy$$

over the sphere $S : x^2 + y^2 + z^2 = 9$ is

(GATE IN 2025)

a) 72π b) 144π c) 36π d) 432π

37) Newton-Raphson method is used to compute the inverse of the number 1.6. Among the following options, the initial guess of the solution that results in non-convergence of the iterative process is

(GATE IN 2025)

a) 0.55 b) 0.75 c) 1.15 d) 1.25

38) The value of the integral $\int_{-\pi}^{\pi} \left(\cos^4 x + \cos^6 x\right) dx$ is

(GATE IN 2025)

a) $\frac{\pi}{2}$ b) $\frac{5\pi}{8}$ c) $\frac{11\pi}{8}$ d) $\frac{9\pi}{8}$

39) Let $y[n] = \frac{1}{\alpha}y[n-1] + x[n]$, where $\alpha > 1$ and real, represent a difference equation of a causal discrete-time LTI system. The system is initially at rest. If $x[n] = \delta[n-p]$ where $p > 10$, the value of $y[p+1]$ is

(GATE IN 2025)

a) 0 b) 1 c) $\frac{1}{\alpha}$ d) $\frac{1}{\alpha^2}$

40) The clock frequency of the digital circuit shown in Fig. 13 is 12 MHz. The frequencies of the output F corresponding to Control = 0 and Control = 1, respectively, are

(GATE IN 2025)

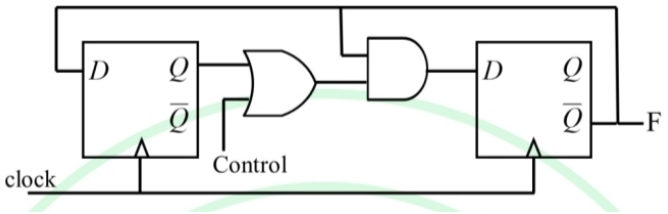


Fig. 13: Digital Circuit for Question-40

a) 4 MHz and 6 MHz
b) 6 MHz and 4 MHz
c) 3 MHz and 4 MHz
d) 3 MHz and 6 MHz

41) A chopper amplifier shown in Fig. 14 is designed to process a biomedical signal $v_{in}(t)$ to generate conditioned output $v_{out}(t)$. The signals $v_{in}(t)$ and $v_{os}(t)$ are band limited to 50 Hz and 10 Hz respectively. For the system to operate as a linear amplifier, choose the correct statement from the following options.

(GATE IN 2025)

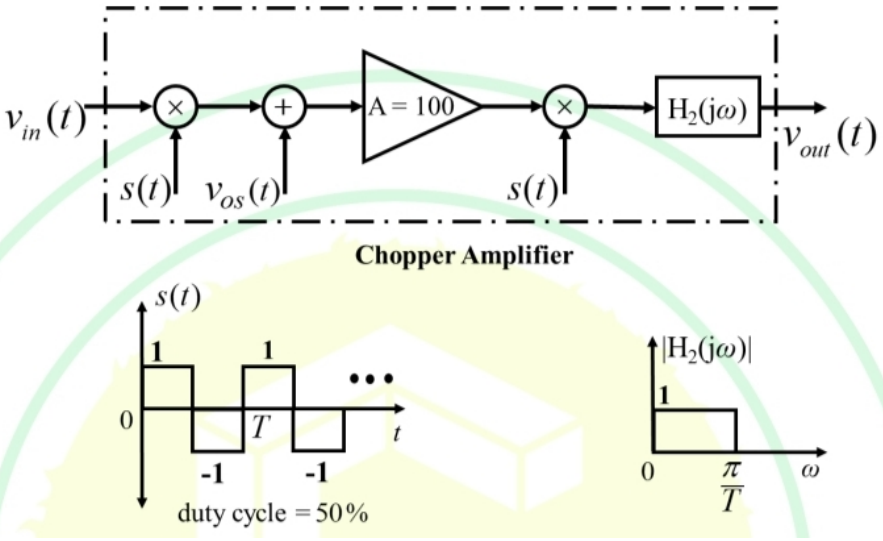
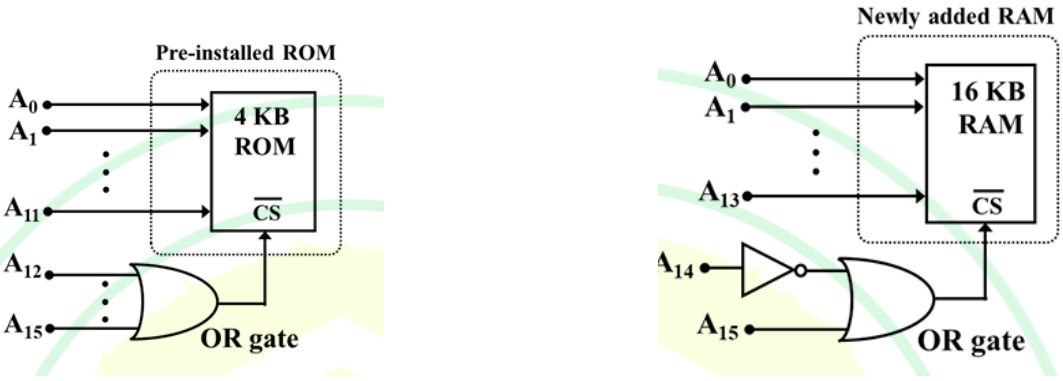


Fig. 14: Diagram for Question-41

a) The minimum frequency of $s(t)$ required is 100 Hz and $v_{os}(t)$ gets attenuated by the system
b) The minimum frequency of $s(t)$ required is 100 Hz and $v_{os}(t)$ also gets amplified by the system by a factor 200

c) The minimum frequency of $s(t)$ required is 80 Hz and $v_{os}(t)$ gets attenuated by the system
d) The minimum frequency of $s(t)$ required is 80 Hz and $v_{os}(t)$ also gets amplified by the system by a factor $\frac{200}{\pi}$

42) An 8-bit microprocessor has 16-bit address bus A_{15}-A_0 where A_0 is the LSB. As shown in Fig. 15a it has a pre-installed 4 KB ROM whose starting address is 0000H. The processor needs to be upgraded by adding a 16 KB RAM as shown in Fig. 15b. The address range for the newly added RAM is
(GATE IN 2025)



(a) Pre-installed ROM (b) Newly Added RAM

Fig. 15: Diagrams for Question-42

a) 1000H - 4FFFH
b) 3000H - 6FFFH
c) 4000H - 7FFFH
d) 8000H - BFFFH

43) A 3-bit DAC is implemented using ideal opamp and switches as shown in Fig. 16. Each of the switches gets closed when its corresponding digital input is at logic 1. For a digital input 110, the resistance R_{in} seen from the reference source and the current I are
(GATE IN 2025)

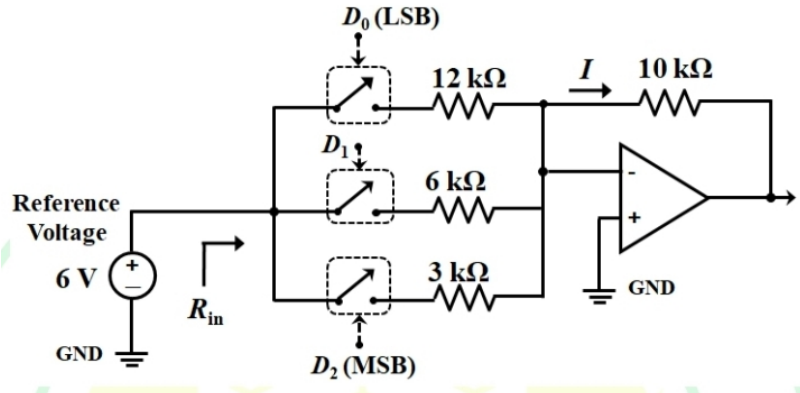


Fig. 16: Arrangement of OpAmp and Switches

a) $R_{in} = 2\,k\Omega$, $I = 3$ mA
b) $R_{in} = 12\,k\Omega$, $I = 0.5$ mA
c) $R_{in} = \infty$, $I = 1$ mA
d) $R_{in} = \infty$, $I = 3$ mA

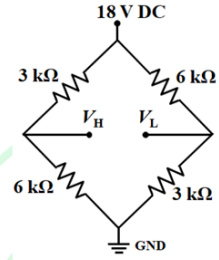
44) Power consumed by a three-phase balanced load is measured using two-wattmeter method. The per-phase average power drawn is 30 kW at $\frac{\sqrt{3}}{2}$ lagging power factor. The readings of the wattmeters will be

(GATE IN 2025)

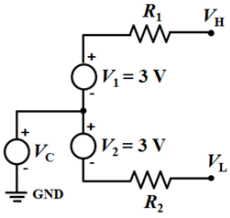
a) 15 kW and 15 kW
b) 22.5 kW and 7.5 kW
c) 60 kW and 30 kW
d) 45 kW and 45 kW

45) The bridge circuit shown in Fig. 17a can be equivalently represented as shown in Fig. 17b. The values of R_1, R_2, and V_c in the equivalent circuit are

(GATE IN 2025)



(a) Bridge Circuit



(b) Equivalent Circuit

Fig. 17: Diagrams for Question-45

a) $R_1 = 6\,k\Omega,\ R_2 = 3\,k\Omega,\ V_c = 9\,V$
b) $R_1 = 3\,k\Omega,\ R_2 = 6\,k\Omega,\ V_c = 4.5\,V$
c) $R_1 = 2\,k\Omega,\ R_2 = 2\,k\Omega,\ V_c = 9\,V$
d) $R_1 = 2\,k\Omega,\ R_2 = 2\,k\Omega,\ V_c = 4.5\,V$

46) A 2-pole, 50 Hz, 3-phase induction motor supplies power to a certain load at 2970 rpm. The torque-speed curve of this machine follows a linear relationship between synchronous speed and 95% of synchronous speed. Assume mechanical and stray losses to be 0. If the load torque of the motor is doubled, the new operating speed (in rpm) is

(GATE IN 2025)

a) 2940 b) 2812 c) 2970 d) 2850

47) Fig. 18 shows a closed-loop system with a plant $G(s) = \frac{1}{s^2}$ and a lead compensator $C(s)$. The compensator is designed to place the dominant closed-loop poles at $-1.5 \pm j\frac{\sqrt{27}}{2}$. From the following options, choose the phase lead that the compensator needs to contribute.

(GATE IN 2025)

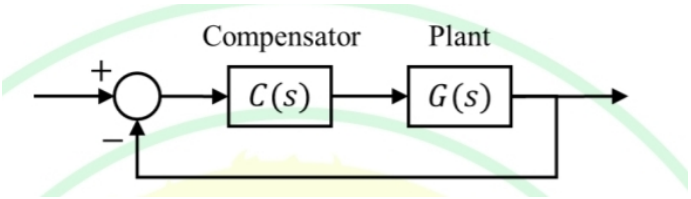


Fig. 18: Closed Loop system

a) 30° b) 60° c) 90° d) 120°

48) Let $f(t)$ and $g(t)$ represent continuous-time real-valued signals. If $h(t)$ denotes cross-correlation between $f(t)$ and $g(-t)$, its continuous-time Fourier transform $H(j\omega)$ equals
Note: $F(j\omega)$ and $G(j\omega)$ denote the continuous-time Fourier transforms of $f(t)$ and $g(t)$ respectively.
(GATE IN 2025)

a) $F(j\omega)\,G(j\omega)$
b) $F(-j\omega)\,G(j\omega)$
c) $F(j\omega)\,G(-j\omega)$
d) $-F(j\omega)\,G(-j\omega)$

49) Choose the correct statement(s) regarding Cauchy's theorem on complex integration $\oint_C f(z)\,dz$ where C is a simple closed path and D is simply connected domain.
(GATE IN 2025)

a) Cauchy's theorem cannot be directly applied to conclude that $\oint_C \frac{1}{z^2}dz = 0$ when C is the unit circle.
b) If $f(z)$ is analytic in D, then $\oint_C f(z)\,dz = 0$ for any simple closed path C in D.
c) The function $f(z)$ must be analytic in D to conclude $\oint_C f(z)\,dz = 0$.
d) $\oint_C f(z)\,dz \neq 0$ when $f(z) = \frac{1}{z^2}$ and C is the unit circle

50) The plant in the feedback control system shown in Fig. 19 is $P(s) = \frac{a}{s^2-b^2}$, $a > 0, \text{and} b > 0$. The type(s) of controller $C(s)$ that cannot stabilize the plant is/are
(GATE IN 2025)

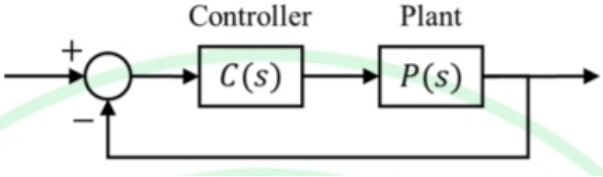


Fig. 19: Feedback Control System

a) proportional (P) controller
b) integral (I) controller
c) proportional-integral (PI) controller
d) proportional-derivative (PD) controller

51) Choose the eigenfunction(s) of stable linear time-invariant continuous-time systems from the following options.
(GATE IN 2025)

a) $e^{j\frac{2\pi}{3}t}$ b) $\cos\left(\frac{2\pi}{3}t\right)$ c) 2^t d) $\sin\left(\frac{2\pi}{3}t\right)$

52) The probability of a student missing a class is 0.1. In a total of 10 classes, the probability that the student will not miss more than one class is _____. (rounded off to two decimal places)
(GATE IN 2025)

53) A metallic strain-gauge (SG) with resistance R_{sg} is connected as shown in Fig. 20, where R_{L1}, R_{L2}, R_{L3} represent lead wire resistances. The SG has a gauge factor of 2 and nominal resistance $R_N = 125\,\Omega$.

When the SG is subjected to a tensile strain of 2×10^{-3}, the resulting change in R_{sg} is ΔR. The ΔR value is measured as $\Delta R_{meas} = R_{eq2} - R_{eq1}$. The R_{eq1} and R_{eq2} are the equivalent resistances measured between the terminals 1 and 2, and terminals 2 and 3, respectively. If $R_{L1} = R_{L2} = 5\,\Omega$, and $R_{L3} = 4.95\,\Omega$, the measured value of tensile strain is _____$\times10^{-3}$ (rounded off to two decimal places).

(GATE IN 2025)

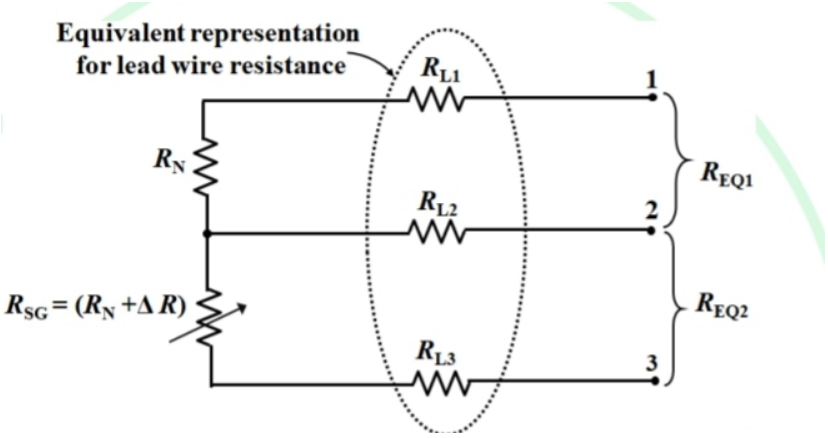


Fig. 20: Combination of Resistors

54) Let $X\left(e^{j\omega}\right)$ represent the discrete time Fourier transform of a 4-length sequence $x[n]$, where $x[0] = 1,\ x[1] = 2,\ x[2] = 2,\ x[3] = 4$. $X\left(e^{j\omega}\right)$ is sampled at $\omega_k = \frac{2\pi k}{3}$ to generate a periodic sequence in k with period 3, where k is an integer. Let $y[n]$ represent another sequence such that its discrete Fourier transform $Y[k]$ is given as $Y[k] = X\left(e^{j\omega_k}\right)$. The value of $y[0]$ is _____.

(GATE IN 2025)

55) A schematic of a Michelson interferometer, used for the measurement of refractive index of gas, is shown in Fig. 21. The transparent chamber is filled with a gas of refractive index n_g where $n_g \neq 1$, at atmospheric pressure. If a 532 nm laser beam produces 30 interference fringes on the screen, then the number of fringes produced by a 632.8 nm laser beam will be _____ (rounded off to one decimal place). Note: Assume the effect of beamsplitter width negligible. The setup is in air medium with refractive index = 1.

(GATE IN 2025)

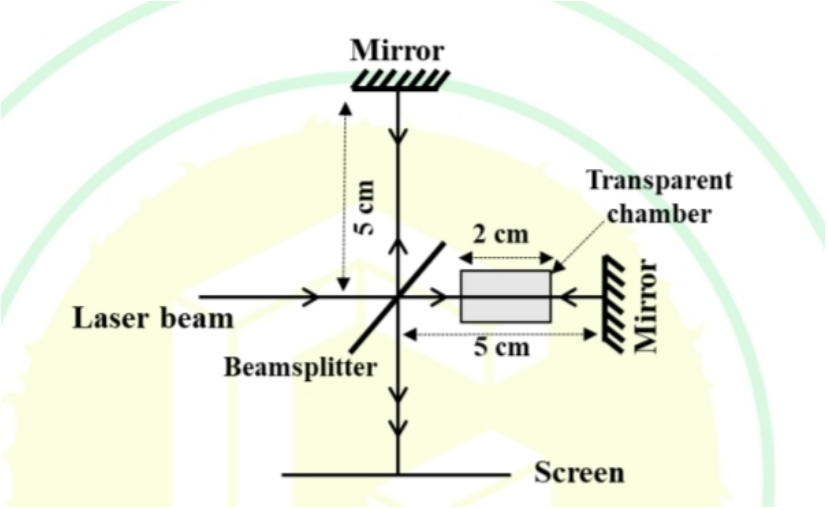


Fig. 21: Michelson Interferometer

56) Consider an AC bridge shown in Fig. 22 with $R = 300\,\Omega$, $R_1 = 1000\,\Omega$, $R_2 = 500\,\Omega$, $L = 30$ mH and detector D. At bridge balance condition, the frequency of the excitation source V_s is _____ kHz (rounded off to two decimal places).

(GATE IN 2025)

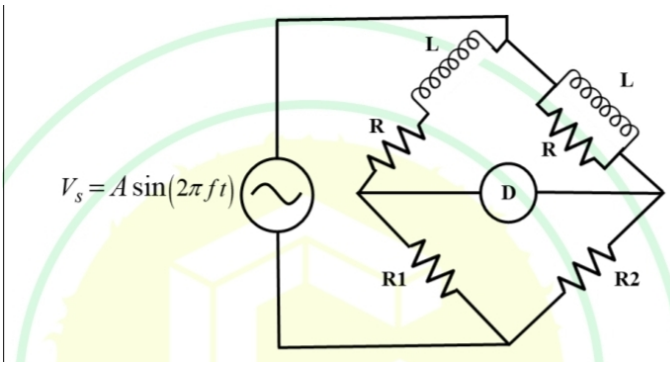
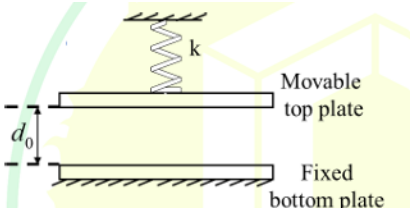


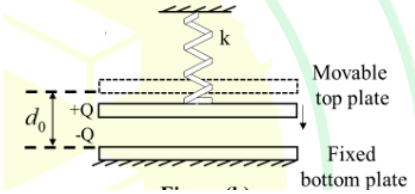
Fig. 22: AC Bridge Circuit

57) An air filled parallel plate electrostatic actuator is shown in the figure. The area of each capacitor plate is $100\,\mu m \times 100\,\mu m$. The distance between the plates $d = 1\,\mu m$ when both the capacitor charge and spring restoring force are zero as shown in Fig. 23a. A linear spring of constant $k = 0.01$ N/m is connected to the movable plate. When charge is supplied to the capacitor using a current source, the top plate moves as shown in Fig. 23b. The magnitude of minimum charge Q required to momentarily close the gap between the plates is _____$\times 10^{-14}$ C (rounded off to two decimal places). Note: Assume full motion is possible and no fringe capacitance. $\epsilon_0 = 8.85 \times 10^{-12}$ F/m, $\epsilon_r = 1$.

(GATE IN 2025)



(a) Equilibrium State



(b) Charge is supplied to capacitor

Fig. 23: Diagrams for Question-57

58) The resistance of a thermistor is measured to be $2.25\,k\Omega$ at $30°C$ and $1.17\,k\Omega$ at $60°C$. Its material constant β is _____ K (rounded off to two decimal places).

(GATE IN 2025)

59) A feedback control system is shown in Fig. 24.

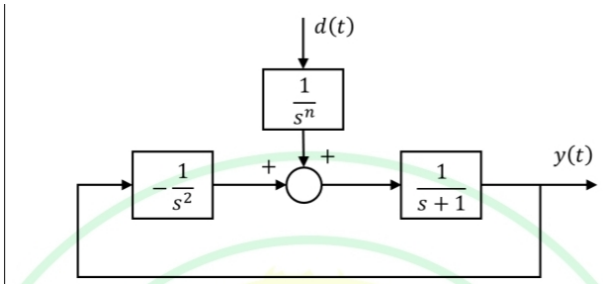


Fig. 24: Feedback Control System

The maximum allowable value of n such that the output $y(t)$, due to any step disturbance signal $d(t)$, becomes zero at steady state, is _____. (in integer)

(GATE IN 2025)

60) The circuit given in Fig. 25 is driven by a voltage source $V = 25\sqrt{2}\angle 30°$ V. Operating at a frequency of 50 Hz, with ideal transformers. The average power dissipated in the $50\,k\Omega$ resistance is _____ W (rounded off to two decimal places).

(GATE IN 2025)

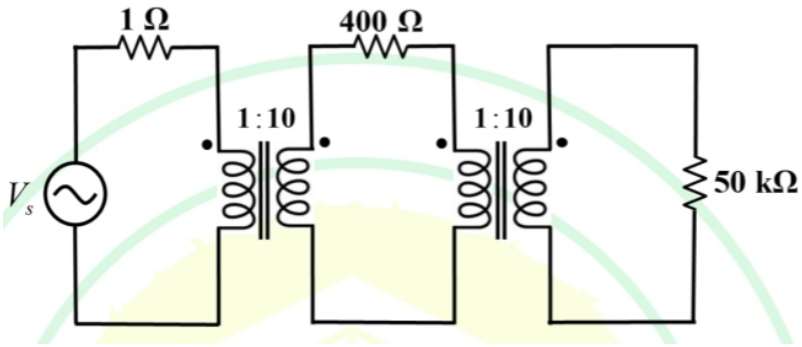


Fig. 25: Circuit Diagram for Question-60

61) In the circuit shown in Fig. 26, the galvanometer (G) has an internal resistance of 100Ω. The galvanometer current I_G = _____ μA (rounded off to nearest integer).

(GATE IN 2025)

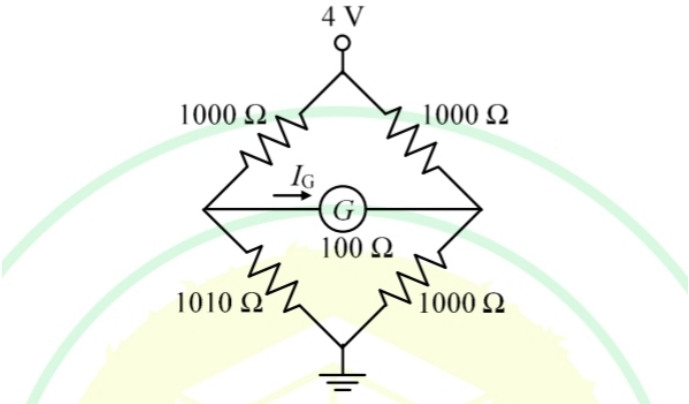


Fig. 26: Bridge Circuit

62) A series RLC circuit resonates at 7500 rad/s for inductance L = 20 mH and resistance R = 10Ω. The uncertainties in L and R are 0.8 mH and 0.3Ω, respectively. The percentage uncertainty in the

measurement of Q is _____% (rounded off to one decimal place).

(GATE IN 2025)

63) In the circuit shown in Fig. 27, the switch is opened at $t = 0$ s. The current $i(t = 2\,ms)$ is _____ mA (rounded off to two decimal places).

(GATE IN 2025)

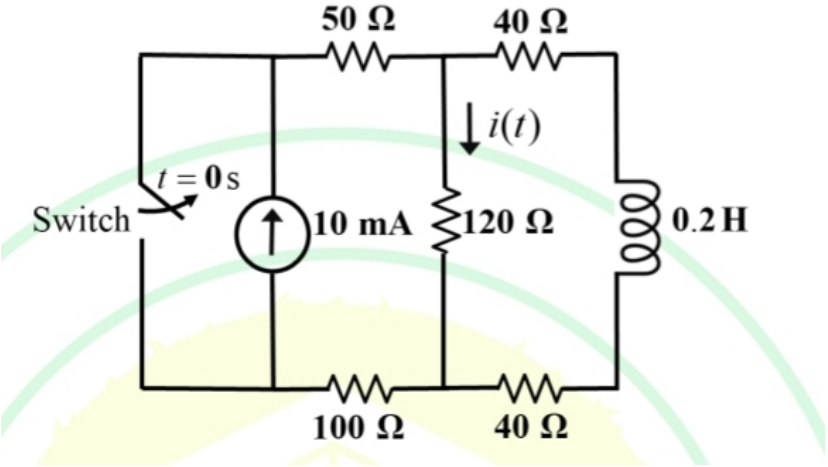


Fig. 27: Circuit for Question-63

64) A signal $v_M = 5\sin\left(\frac{\pi}{3}t\right)$ V is applied to the circuit consisting of a switch S and capacitor $C = 0.1\,\mu F$, as shown in Fig. 28. The output V_x is fed to an ADC having $10\,M\Omega$ in parallel with $0.1\,\mu F$. If S is opened at $t = 0.5$ s, the value of V_x at $t = 1.5$ s will be _____ V (rounded off to two decimal places).

(GATE IN 2025)

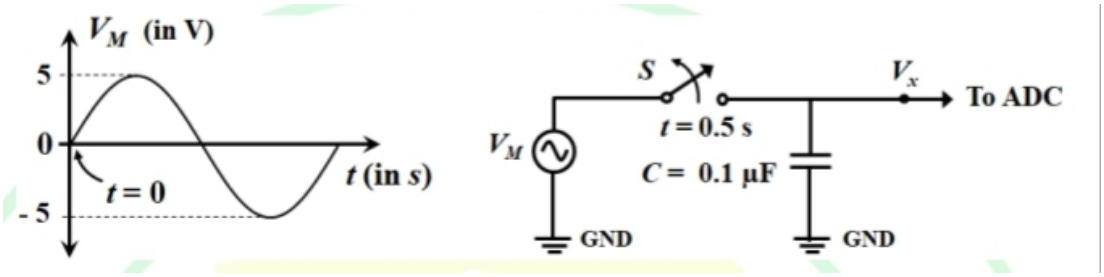


Fig. 28: Circuit and Graph for Question-64

65) For the circuit shown in Fig. 29, the active power supplied by the source is _____ W (rounded off to one decimal place.

(GATE IN 2025)

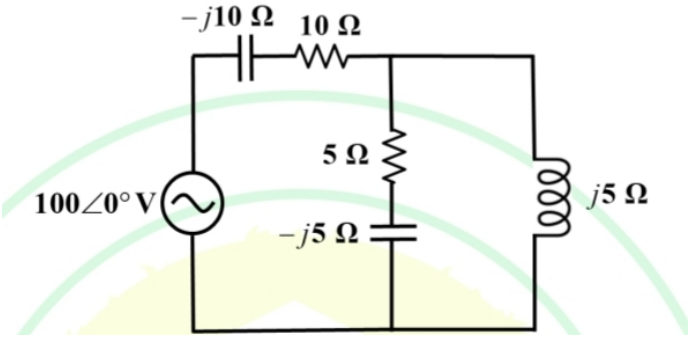


Fig. 29: Circuit for Question-65