IN INSTRUMENTATION ENGINEERING

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1) If ' → ' denotes increasing order of intensity, then the meaning of the words [drizzle → rain → downpour] is analogous to [_____ → quarrel → feud]. Which one of the given options is appropriate to fill the blank?

(GATE IN 2024)

a) bicker b) bog c) dither d) dodge

2) Statements:
1. All heroes are winners.
2. All winners are lucky people.
Inferences:
I. All lucky people are heroes.
II. Some lucky people are heroes.
III. Some winners are heroes.
Which of the above inferences can be logically deduced from statements 1 and 2?

(GATE IN 2024)

a) Only I and II b) Only II and III c) Only I and III d) Only III

3) A student was supposed to multiply a positive real number p with another positive real number q. Instead, the student divided p by q. If the percentage error in the student's answer is 80%, the value of q is

(GATE IN 2024)

a) 5 b) $\sqrt{2}$ c) 2 d) $\sqrt{5}$

4) If the sum of the first 20 consecutive positive odd numbers is divided by 20^2, the result is

(GATE IN 2024)

a) 1 b) 20 c) 2 d) $\frac{1}{2}$

5) The ratio of the number of girls to boys in class VIII is the same as the ratio of the number of boys to girls in class IX. The total number of students (boys and girls) in classes VIII and IX is 450 and 360, respectively. If the number of girls in classes VIII and IX is the same, then the number of girls in each class is

(GATE IN 2024)

a) 150 b) 200 c) 250 d) 175

6) In the given text, the blanks are (i) - (iv) in their order of occurence. Select the best match for all the blanks.
Yoko Roi stands _____ as an author for standing _____ as an honorary fellow, after she stood _____ her writings that stand _____ the freedom of speech.

(GATE IN 2024)

a) i) out
ii) down
iii) in
iv) for

b) i) down
ii) out
iii) by
iv) in

c) i) down
ii) out
iii) for
iv) in

d) i) out
ii) down
iii) by
iv) for

7) Seven identical cylindrical chalk-sticks are fitted tightly in a cylindrical container. Fig. 1 shows the arrangement of the chalk-sticks inside the cylinder. The length of the container is equal to the length of the chalk-sticks. The ratio of the occupied space to the empty space of the container is

(GATE IN 2024)

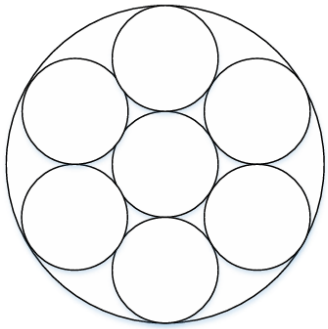


Fig. 1. Chalk-sticks in a container

a) $\frac{5}{2}$ b) $\frac{7}{2}$ c) $\frac{9}{2}$ d) 3

8) The plot in Fig. 2 shows the relationship between the mortality risk of cardiovascular disease and the number of steps a person walks per day. Based on the data, which one of the following options is true?

(GATE IN 2024)

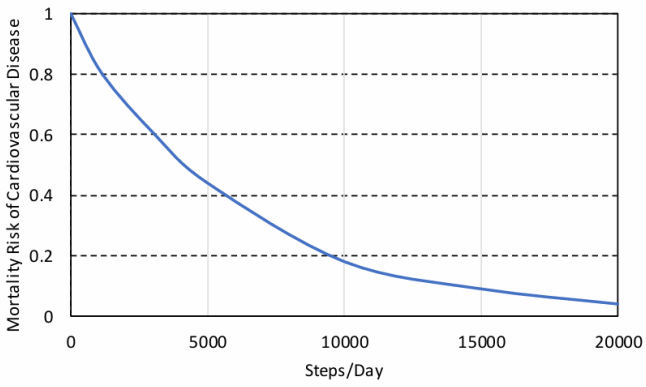


Fig. 2. Graph for Question 8

a) The risk reduction on increasing the steps/day from 0 to 10,000 is less than the risk reduction on increasing the steps/day from 10,000 to 20,000.

b) The risk reduction on increasing the steps/day from 0 to 5,000 is less than the risk reduction on increasing the steps/day from 15,000 to 20,000.

c) For any 5,000 increment in steps/day, the largest risk reduction occurs on going from 0 to 5,000.

d) For any 5,000 increment in steps/day, the largest risk reduction occurs on going from 15,000 to 20,000.

9) Five cubes of identical size and another smaller cube are assembled as shown in Fig. 3. If viewed from direction X, the planar image of the assembly appears in Fig. 3. If viewed from direction Y, the planar image of the assembly (in the left of the figure) will appear as

(GATE IN 2024)

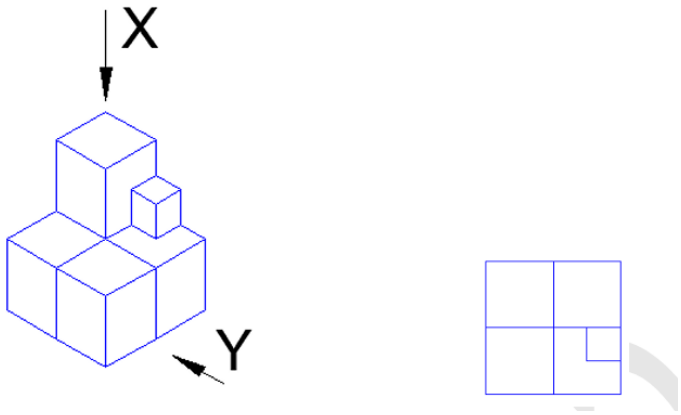
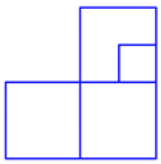
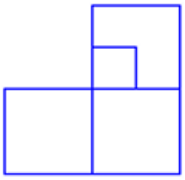


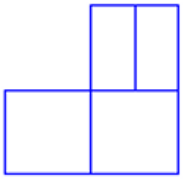
Fig. 3. Arrangement of Cubes



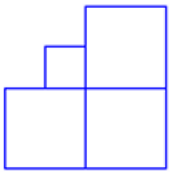
a)



c)



b)



10) Visualize a cube that is held with one of the four body diagonals aligned to the vertical axis. Rotate the cube about this axis such that its view remains unchanged. The magnitude of the minimum angle of rotation is

(GATE IN 2024)

a) 120° b) 60° c) 90° d) 180°

11) Let $z = x + iy$ be a complex variable and $\bar{z}$ be its complex conjugate. The equation $\bar{z}^2 + z^2 = 2$ represents a

(GATE IN 2024)

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

12) The pressure drop across a control valve is constant. The control valve with inherent characteristic has decreasing sensitivity. If x represents the fraction of maximum stem position of the control valve, then the function $f(x)$ representing the fraction of maximum flow is

(GATE IN 2024)

a) α^{x-1}, where α is constant
b) $\sqrt{x}$
c) x
d) x^2

13) A discrete-time sequence is given by $x[x] = [1, 2, 3, 4]$ for $0 \leq n \leq 3$. The zero lag auto-correlation value of $x[x]$ is

(GATE IN 2024)

a) 1
b) 10
c) 20
d) 30

14) Match the following measuring devices with their principle of measurement.

Measuring Device	Principle of Measurement
(P) Optical pyrometer	(I) Variation in mutual inductance
(Q) Thermocouple	(II) Change in resistance
(R) Strain gauge	(III) Wavelength of radiated energy
(S) Linear variable differential transformer	(IV) Electromotive force generated by two dissimilar metals

(GATE IN 2024)

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

15) The capacitor shown Fig. 4 has parallel plates, with each plate having an area A. The thickness of the dielectric materials are d_1 and d_2 and their relative permittivities are ε_1 and ε_2, respectively. Assume that the fringing field effects are negligible and ε_0 is the permittivity of free space.

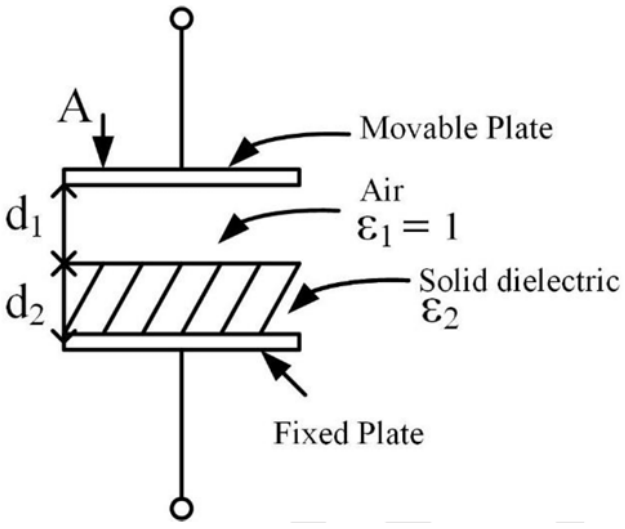


Fig. 4. Parallel Plate Capacitor

If d_1 is decreased by δd_1, the resultant capacitance becomes

(GATE IN 2024)

a) $\frac{\varepsilon_0 A}{d_1 - \delta d_1 + \frac{d_2}{\varepsilon_2}}$ b) $\frac{\varepsilon_0 A}{d_2 + \frac{d_1}{\varepsilon_2}}$ c) $\frac{\varepsilon_0 A}{d_2 - \delta d_2 + \frac{d_1}{\varepsilon_2}}$ d) $\frac{\varepsilon_0 A}{d_1 + \delta d_1 + \frac{d_2}{\varepsilon_2}}$

16) Among the given options, the simplified form of the Boolean function $F = (A + \bar{A} \cdot B) + \bar{A} \cdot (A + \bar{B}) \cdot C$ is

(GATE IN 2024)

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

17) Consider the state-space representation of a system

$$\dot{x} = Ax + Bu$$

where x is the state vector, u is the input, A is the system matrix and B is the input matrix. Choose the matrix A from the following options such that the system has a pole at the origin.

(GATE IN 2024)

a) $\begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix}$
b) $\begin{pmatrix} 1 & -1.5 \\ -2 & 3 \end{pmatrix}$
c) $\begin{pmatrix} 1 & 1.5 \\ 2 & -3 \end{pmatrix}$
d) $\begin{pmatrix} 0 & 1 \\ -2 & 3 \end{pmatrix}$

18) The sinusoidal transfer function corresponding to the polar plot shown in Fig. 5, for $T > 0$, is

(GATE IN 2024)

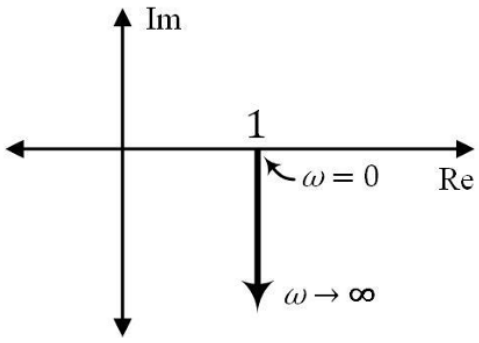


Fig. 5. Polar Plot

a) $1 - j\omega T$ b) $\frac{1 - j\omega T}{1 + j\omega T}$ c) $1 + j\omega T$ d) $\frac{1}{1 + j\omega T}$

19) A matrix M is constructed by stacking three column vectors v_1, v_2, v_3 as

$$M = \begin{pmatrix} v_1 & v_2 & v_3 \end{pmatrix}$$

. Choose the set of vectors from the following options such that rank(M) = 3.

(GATE IN 2024)

a) $v_1 = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}, \ v_2 = \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix}, \ v_3 = \begin{pmatrix} 1 \\ -1 \\ 1 \end{pmatrix}$

b) $v_1 = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \ v_2 = \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix}, \ v_3 = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$

c) $v_1 = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}, \ v_2 = \begin{pmatrix} -1 \\ 0 \\ 1 \end{pmatrix}, \ v_3 = \begin{pmatrix} 1 \\ -1 \\ 1 \end{pmatrix}$

d) $v_1 = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \ v_2 = \begin{pmatrix} -1 \\ 1 \\ -1 \end{pmatrix}, \ v_3 = \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix}$

20) The capacitance formed between two concentric spherical metal shells having radii x and y with $y > x$ is (ϵ is the permittivity of the medium between the shells).

(GATE IN 2024)

a) $4\pi\epsilon\left(\frac{xy}{y-x}\right)$ b) $4\pi\epsilon\left(\frac{x^2}{y-x}\right)$ c) $4\pi\epsilon\left(\frac{y^2}{y-x}\right)$ d) $4\pi\epsilon\left(\frac{y^2-xy}{x}\right)$

21) A linear transducer is calibrated for the ranges shown in Fig. 6. The gain of the transducer is _____ mA/°C (rounded off to two decimal places).

(GATE IN 2024)

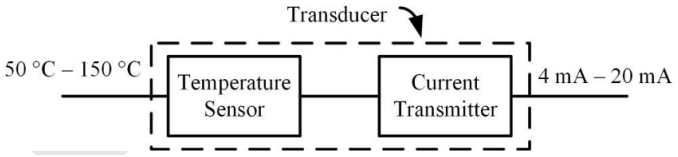


Fig. 6. Linear Transducer

22) Consider a filter defined by the difference equation $y[n] - 0.5\,y[n-2] = a\,x[n-4]$ where $x[n]$ and $y[n]$ represent the input and output, respectively. If the magnitude response of the filter at $\omega = \frac{\pi}{2}$ is $|H(\frac{\pi}{2})| = 0.5$, the value of a is _____ (rounded off to two decimal places).

(GATE IN 2024)

23) Consider the circuit shown in Fig. 7.

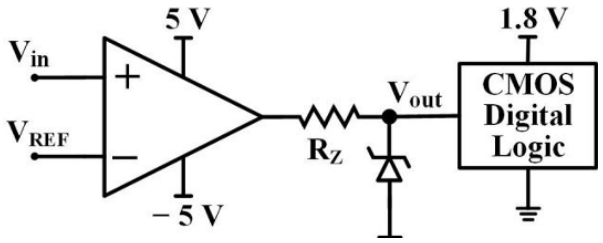


Fig. 7. Circuit Diagram for Question-23

The CMOS digital logic circuit has infinite input impedance. Assume the opamp is ideal. A 1.8V Zener diode with a minimum Zener current of 2mA is used. The corresponding maximum value of resistance R_Z is _____ kΩ (rounded off to one decimal place).

(GATE IN 2024)

24) Fig. 8 shows an amplifier using an NMOS transistor. Assume that the transistor is in saturation with device parameters, $\mu_n C_{ox} = 250\ \mu\text{A/V}^2$, threshold voltage $V_T = 0.65$ V and $W/L = 4$. Ignore the channel length modulation effect. The drain current of the transistor at the operating point is _____ μA (rounded off to nearest integer).

(GATE IN 2024)

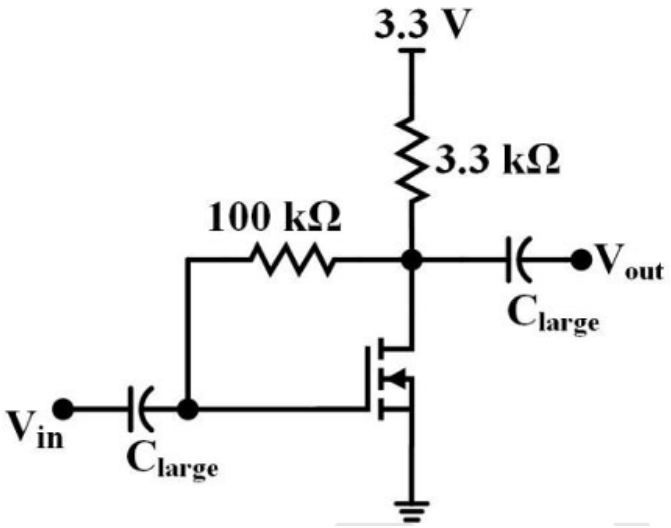


Fig. 8. Amplifier using NMOS Transistor

25) The number of complex multiplications required for computing a 16-point DFT using the decimation-in-time radix-2 FFT is _____ (in integer).

(GATE IN 2024)

26) A 3×3 matrix P with all real elements has eigenvalues $\frac{1}{4}$, 1, and -2. The value of $\left|P^{-1}\right|$ is _____ (rounded off to nearest integer).

(GATE IN 2024)

27) The Nyquist sampling frequency for $x(t) = 10\sin^2(200\pi t)$ is _____ Hz (rounded off to nearest integer).

(GATE IN 2024)

28) The resistance of a 20 kΩ resistor is measured six consecutive times using an LCR meter. The first five readings are 19 kΩ, 18 kΩ, 23 kΩ, 21 kΩ and 17 kΩ.
If the mean of the measurements and the true value are equal, the last reading is _____ kΩ (rounded off to nearest integer).

(GATE IN 2024)

29) Consider the readout circuit of a piezoelectric sensor shown Fig. 9.
When the piezoelectric sensor generates a charge q_p, the resulting change in voltage V_x is -2 V. Then the corresponding change in the voltage V_{out} is _____ V (rounded off to nearest integer).
Note: Assume all components are ideal.

(GATE IN 2024)

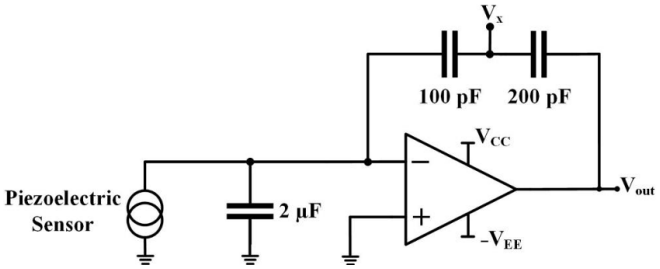


Fig. 9. Readout Circuit of a Piezoelectric Sensor

30) The voltage applied and the current drawn by a circuit are

$$v(t) = 95 + 200\cos(120\pi t) + 90\cos(360\pi t - 60°)\ \text{V}$$

$$i(t) = 4\cos(120\pi t - 60°) + 1.5\cos(240\pi t - 75°)\ \text{A}$$

The average power absorbed by the circuit is _____ W (rounded off to nearest integer).

(GATE IN 2024)

31) The current $i(t)$ drawn by a circuit is given as
$i(t) = 4 + 30\cos(t) - 20\sin(t) + 15\cos(3t) - 10\sin(3t)$ A
The root-mean-square value of $i(t)$ is _____ A (rounded off to one decimal place).

(GATE IN 2024)

32) A linear potentiometer (0 – 10 kΩ) is used to measure the water level as shown in Fig. 10. The resistance between A and C varies linearly from 0 to 10 kΩ for a change in water level from 0 to 20cm. The sensor is excited using a DC voltage source, V_S = 10 V with an internal resistance, R_S = 200 Ω. If V_{out} = 5 V, the water level is _____ cm (rounded off to one decimal place).

(GATE IN 2024)

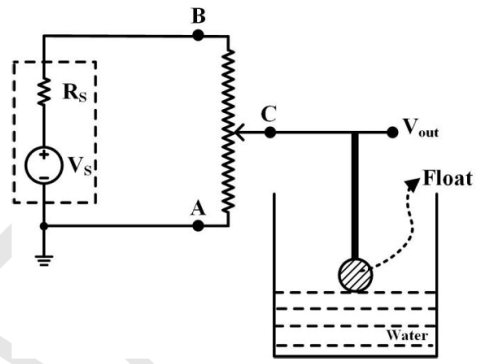


Fig. 10. Diagram for Question-32

33) The switch in Fig. 11 has been closed for a long time ($t < 0$). It is opened at $t = 0$ seconds. The value of $\frac{dv_c}{dt}$ at $t = 0^+$ is _____ V/s (rounded off to nearest integer).

(GATE IN 2024)

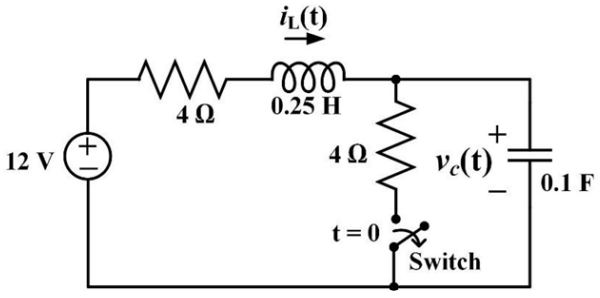


Fig. 11. Circuit Diagram for Question-33

34) Consider a system given by the following first order differential equation:

$$\frac{dy}{dt} = y + 2t - t^2$$

where, $y(0) = 1$ and $0 \le t < \infty$. Using a step size $h = 0.1$ for the improved Euler method, the value of $y(t)$ at $t = 0.1$ is _____ (rounded off to two decimal places).

(GATE IN 2024)

35) Indian Premier League has divided the sixteen cricket teams into two equal pools: Pool-A and Pool-B. Four teams of Pool-A have blue logo jerseys while the rest four have red logo jerseys. Five teams of Pool-B have blue logo jerseys while the rest three have red logo jerseys.
If one team from each pool reaches the final, the probability that one team has a blue logo jersey and another has a red logo jersey is _____ (rounded off to one decimal place).

(GATE IN 2024)

36) A wire of circular cross section with radius a is shown in Fig. 12. The current density is given by $J = ks^2$, where k is a constant, s is the radial distance from the axis and $0 \leq s \leq a$. The total current I in the wire is

(GATE IN 2024)

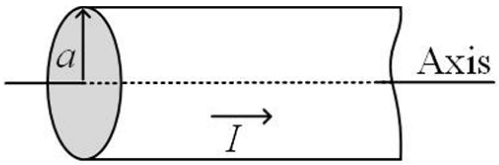


Fig. 12. Wire of Circular Cross Section

a) $\frac{\pi k a^4}{2}$ b) $\frac{2\pi k a^3}{3}$ c) $\frac{\pi k a^3}{2}$ d) $\frac{\pi k a^4}{4}$

37) The measured values from a flow instrument, whose range is between 0 and 2 flow units, are shown in the histogram in Fig. 13. The systematic error (bias) and the maximum error (in flow units), respectively are

(GATE IN 2024)

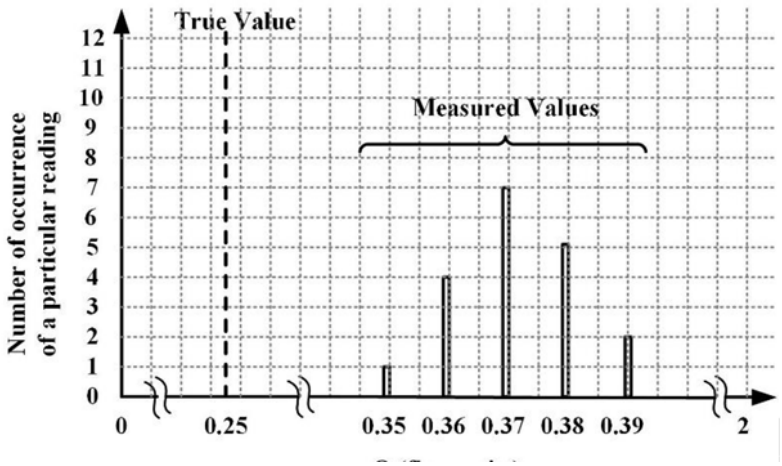


Fig. 13. Histogram for Question-37

a) 0.12 and 0.14 b) 0.01 and 0.10 c) 0.10 and 0.14 d) 0.04 and 0.12

38) Consider a discrete-time sequence

$$x[n] = \begin{cases} (0.2)^n, & 0 \leq n \leq 7, \\ 0 & \text{otherwise} \end{cases}$$

. The region of convergence of $X(z)$, the z-transform of $x[n]$, consists of

(GATE IN 2024)

a) all values of z except $z = 0.2$
b) all values of z
c) all values of z except $z = 0$
d) all values of z except $z = \infty$

39) In the bridge circuit shown in Fig. 14, under balanced condition, the values of R and C respectively, are

(GATE IN 2024)

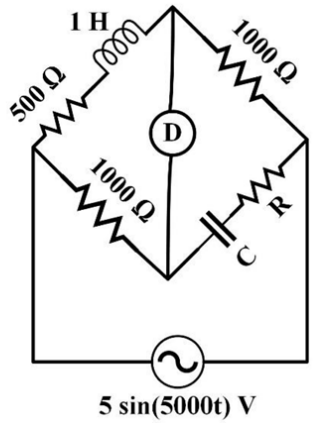


Fig. 14. Bridge Circuit

a) $1.010\,\Omega$ and $19.802\,\mu$F
b) $9.901\,\Omega$ and $0.505\,\mu$F
c) $19.802\,\Omega$ and $1.01\,\mu$F
d) $39.604\,\Omega$ and $2.02\,\mu$F

40) Laplace transform of a signal $x(t)$ is

$$X(s) = \frac{1}{s^2 + 13s + 42}$$

Let $u(t)$ be the unit step function. Choose the signal $x(t)$ from the following options if the region of convergence is $-7 < Re\{s\} < -6$.

(GATE IN 2024)

a) $-e^{-6t}u(t) - e^{-7t}u(-t)$
b) $-e^{-6t}u(-t) - e^{-7t}u(t)$
c) $e^{-6t}u(t) - e^{-7t}u(-t)$
d) $-e^{-6t}u(-t) - e^{-7t}u(-t)$

41) In Fig. 15, both the opamps A_1 and A_2 are ideal, except that the opamp A_1 has an offset voltage (V_{os}) of 1 mV. For $V_{in} = 0$ V, the values of the output voltages V_{out1} and V_{out2}, respectively, are

(GATE IN 2024)

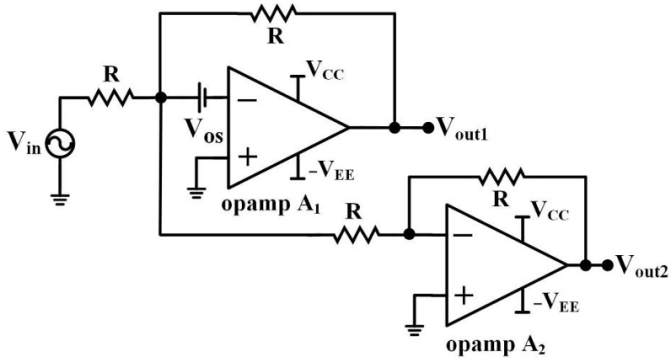


Fig. 15. Circuit Diagram for Question-41

a) 3 mV and −1 mV b) 1 mV and 0 mV c) 1 mV and −1 mV d) 2 mV and 0 mV

42) In Fig. 16, the positive edge triggered D flip-flops are initially reset to $Q = 0$. The logic gates and the multiplexers have no propagation delay. After reset, a train of clock pulses (CLK) are applied. The logic-states of the inputs DIN, S and the clock pulses are also shown in the figure. Assuming no timing violations, the sequence of output Y from the 3rd clock to the 5th clock, $Y_3Y_4Y_5$ is

(GATE IN 2024)

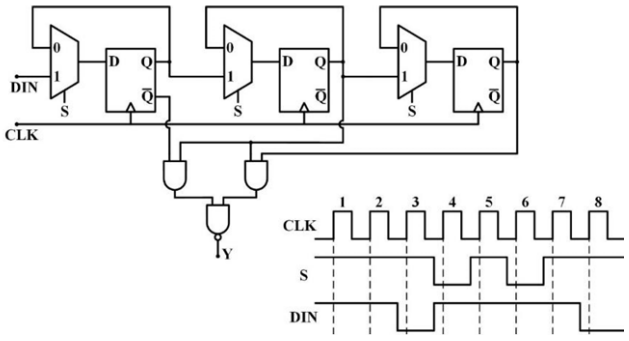


Fig. 16. Circuit Diagram for Question 42

a) 001 b) 010 c) 000 d) 011

43) In Fig. 17, $R = 1$ kΩ and $C = 0.1$ μF. For a dc gain of −10, the 3 dB cut-off frequency (rounded off to one decimal place) is
Assume the opamp is ideal.

(GATE IN 2024)

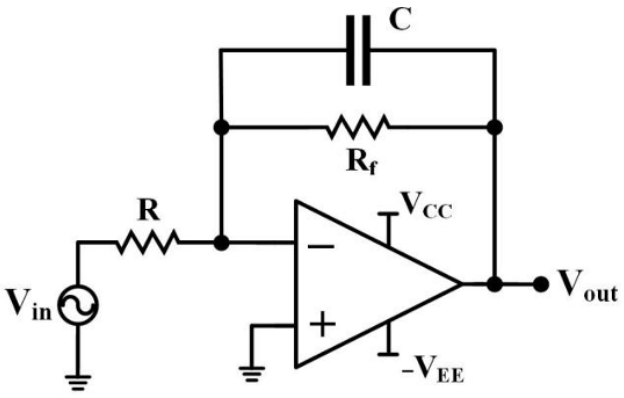


Fig. 17. Circuit Diagram for Question 43

a) 159.1 Hz b) 1591.5 Hz c) 1750.7 Hz d) 175.0 Hz

44) Consider the feedback control system shown in Fig. 18. The steady-state error $e_{ss} = \lim_{t\to\infty}(r(t) - y(t))$ due to unit step reference $r(t)$ is

(GATE IN 2024)

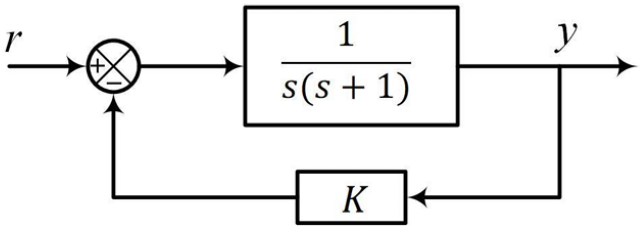


Fig. 18. Feedback Control System

a) $\frac{K-1}{K}$ b) $\frac{1}{2}$ c) 0 d) $\frac{1-K}{K}$

45) The transfer function of a system is

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

Choose the range of ξ and ω_n (in rad/s) from the following options such that the poles lie on the shaded region of the s-plane as shown in Fig. 19.

(GATE IN 2024)

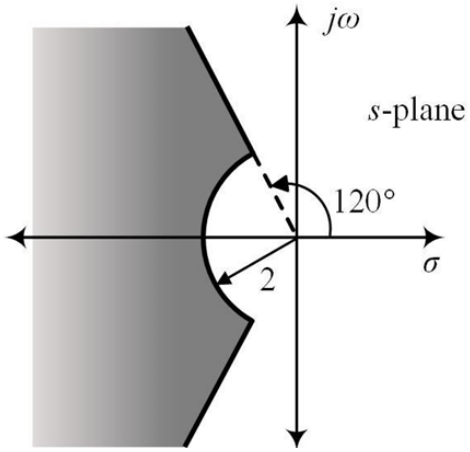


Fig. 19. Diagram for Question-45

a) $\xi \geq \frac{1}{2}$ and $\omega_n \geq 2$ b) $\xi \geq \frac{1}{4}$ and $\omega_n \geq 2$ c) $\xi \geq \frac{1}{2}$ and $\omega_n \geq \sqrt{3}$ d) $\xi \geq \frac{1}{4}$ and $\omega_n \geq \sqrt{3}$

46) Let C be the closed curve in the xy-plane, traversed in the counterclockwise direction along the boundary of the rectangle with vertices at $(0, 0), (2, 0), (2, 1), (0, 1)$. The value of the line integral

$$\oint_C (-e^y\,dx + e^x\,dy)$$

is

(GATE IN 2024)

a) $e^2 + 2e - 3$ b) $e^2 - 2e - 3$ c) $e^2 + e - 1$ d) $e^2 + e + 1$

47) In Fig. 20, assume

- α is the phase angle between the load current and the load voltage,
- β is the phase angle by which pressure coil current lags the pressure coil voltage of the wattmeter,
- γ is the phase angle between currents in the pressure coil and the current coil of the wattmeter,

- δ is the phase angle of the voltage transformer,
- θ is the phase angle of the current transformer.

When the load has a lagging phase angle of α, which one of the following options is correct?

(GATE IN 2024)

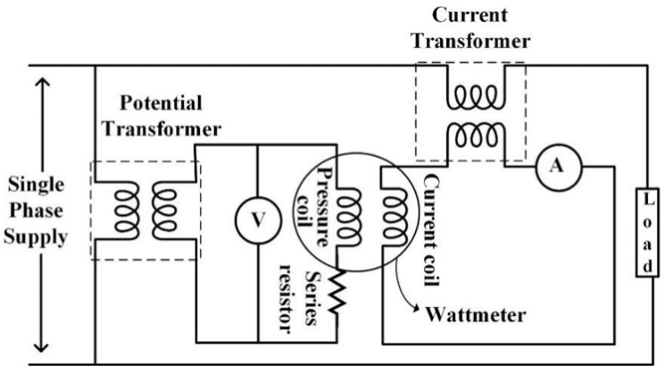


Fig. 20. Diagram for Question-47

a) $\alpha = -\gamma \pm \delta \pm \theta - \beta$ b) $\alpha = -\gamma \pm \delta \pm \theta + \beta$ c) $\alpha = \gamma \pm \delta \pm \theta + \beta$ d) $\alpha = \gamma \pm \delta \pm \theta - \beta$

48) Consider an ultrasonic measurement system shown in the figure. The ultrasonic transmitter (t) sends a continuous wave signal $x(t) = \cos(2\pi f_1 t)$ volts towards an object whose vibration is modeled as $m(t) = 0.5\sin(2\pi f_2 t)$ volts. Neglecting the phase shift due to any other effect, the received signal at the receiver (R) is

$$y(t) = \cos\left(2\pi f_1 t + \beta\cos(2\pi f_2 t)\right) \text{ volts.}$$

Assuming the frequency sensitivity factor as 500 Hz/volt, f_1 = 40 kHz, f_2 = 1 kHz, the modulation index (β) and the frequency deviation in $y(t)$, respectively, are

(GATE IN 2024)

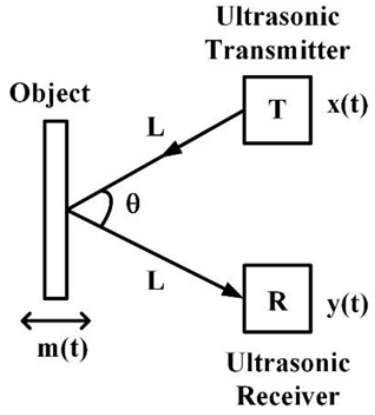


Fig. 21. Ultrasonic Measurement System

a) 0.25 and ±250 Hz b) 0.5 and ±500 Hz c) 1 and ±1000 Hz d) 0.75 and ±1000 Hz

49) The complex functions $f(z) = u(x,y) + i\,v(x,y)$ and $\bar{f}(z) = u(x,y) - iv(x,y)$ are both analytic in a given domain. Choose the correct option(s) from the following.

(GATE IN 2024)

a) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y} = 0$ b) $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x} \neq 0$ c) $\frac{df(z)}{dz} = 0$ d) $\frac{df(z)}{dz} \neq 0$

50) The readings recorded from a 20-psig pressure gauge are given in the Table. The regression line obtained for the data is $y = 0.04x + 10.32$. The regression coefficient of determination, R^2 = _____ (rounded off to three decimal places).

x	1	2	3	4	5
$y\,(psig)$	10.3	10.5	10.4	10.5	10.5

51) In Fig. 22, R = 4.5 kΩ, ΔR = 1.5 kΩ, and INA is assumed to be ideal. The equivalent resistance between A and B is _____ kΩ (rounded off to nearest integer).

(GATE IN 2024)

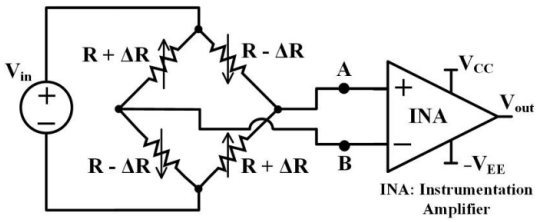


Fig. 22. Diagram for Question-51

52) Consider the capacitive sensor circuit and its output voltage shown in Fig. 23. The circuit is switched ON at t = 0. Assuming the opamp to be ideal, the frequency of the output voltage V_o is _____ kHz (rounded off to two decimal places).

(GATE IN 2024)

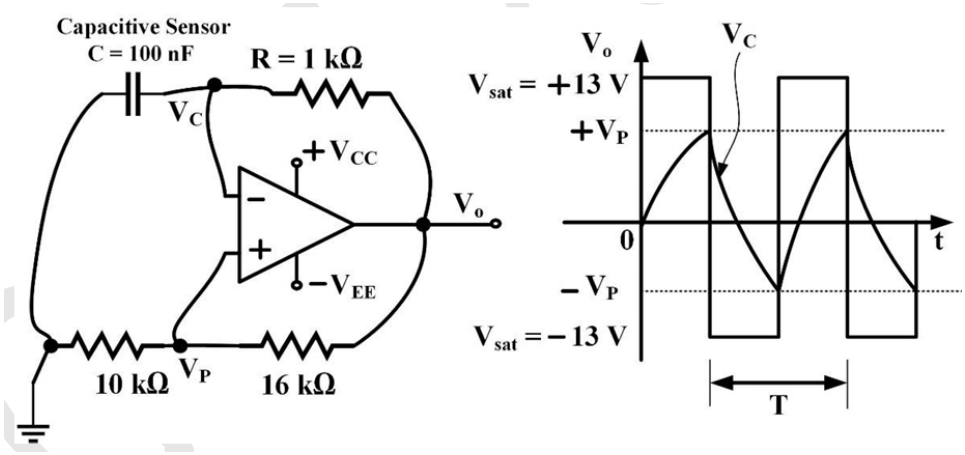


Fig. 23. Diagram for Question-52

53) The 4-point DFTs of two sequences $x[n]$ and $y[n]$ are $X[k] = [1, -j, 1, j]$ and $Y[k] = [1, 3j, 1, -3j]$, respectively. Assuming $z[n]$ represents the 4-point circular convolution of $x[n]$ and $y[n]$, the value of $z[0]$ is _____ (rounded off to nearest integer).
Note: The DFT of an N-point sequence $x[n]$ is defined as

$$X[k] = \sum_{n=0}^{N-1} x[n]\, e^{\frac{-j2\pi nk}{N}}.$$

(GATE IN 2024)

54) Consider Fig. 24. For zero deflection in the galvanometer, the required value of resistor R_x is _____ Ω (rounded off to nearest integer).

(GATE IN 2024)

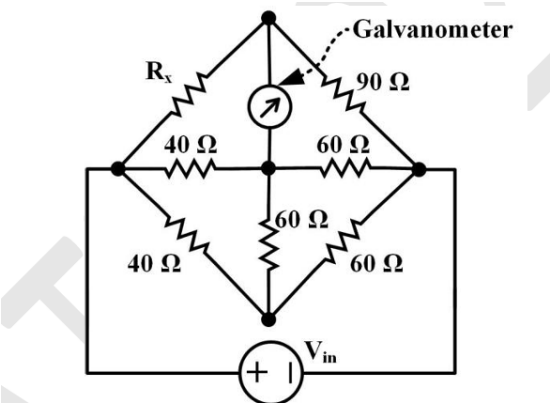


Fig. 24. Diagram for Question-54

55) Consider a unity negative feedback system with its open-loop pole-zero map as shown in Fig. 25. If the point $s = j\alpha$, $\alpha > 0$, lies on the root locus, the value of α is _____ (rounded off to nearest integer). Note: The poles are marked with × in the figure.

(GATE IN 2024)

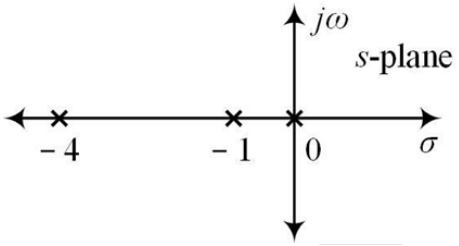


Fig. 25. Open-Loop Pole-Zero map

56) A shielded cable with C_{stray} = 20 pF and R_{wire} = 10 Ω is used to connect the inductive sensors as shown in the figure. The RMS value of V_{out} is _____ V (rounded off to two decimal places). Note: Assume all components are ideal, and sensors are not magnetically coupled.

(GATE IN 2024)

57) In Fig. 26, the diode current is given by $I_D = I_S e^{\alpha V_D/T}$. V_D is the diode voltage in volts, T is the absolute temperature in Kelvin, $\alpha = 1.16 \times 10^4$ K/V, and $I_S = 10^{-15}$ A is the saturation current. The dc current source, opamp and the resistors are ideal, and are assumed to be temperature independent. The change in the output voltage (V_{out}) per Kelvin change in temperature is _____ mV (rounded off to one decimal place).

(GATE IN 2024)

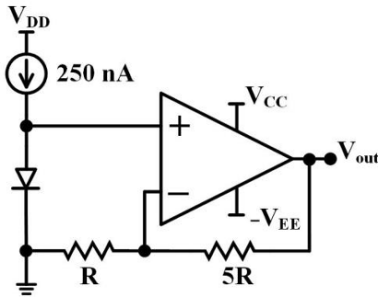


Fig. 26. Diagram for Question-57

58) An ADC has a full scale voltage of 1.4 V, resolution of 200 mV, and produces binary output data. The input signal of the ADC has a bandwidth of 500 MHz, and it samples the data at the Nyquist rate. The parallel data output is converted to a serial bit stream using a parallel-to-serial converter. The data rate at the output of the parallel-to-serial converter is _____ Gbps (rounded off to nearest integer).

(GATE IN 2024)

59) In the circuit shown in Fig. 27, assume the opamp is ideal and the initial charge on the capacitor is zero. The output voltage at time $t = 2$ ms is _____ V (rounded off to one decimal place).

(GATE IN 2024)

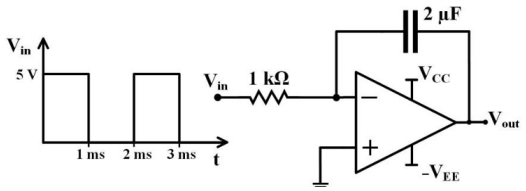


Fig. 27. Diagram for Question-59

60) In Fig. 28, SW is a switch whose position changes from 1 to 0 when V_C changes from logic HIGH to LOW and vice versa. The bandwidth of the permanent magnet moving coil (PMMC) type voltmeter is 1 Hz. If $V_{sense} = 2\sin(4000\pi t)$ V and $V_{ref} = 4\sin(2000\pi t)$ V, the voltmeter reading is _____ V (rounded off to nearest integer).
Note: Assume all components are ideal.

(GATE IN 2024)

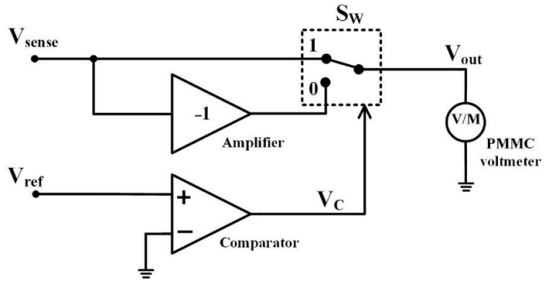


Fig. 28. Diagram for Question-60

61) A 50kVA transformer has an efficiency of 95% at full load and unity power factor. Assume the core losses are negligible. The efficiency of the transformer at 75% of the full load and 0.8 power factor is _____% (rounded off to one decimal place).

(GATE IN 2024)

62) A three-phase squirrel-cage induction motor has a starting torque of 100% of the full load torque and a maximum torque of 300% of the full load torque. Neglecting the stator impedance, the slip at the maximum torque is _____% (rounded off to two decimal places).

(GATE IN 2024)

63) Two magnetically coupled coils, when connected in series-aiding configuration, have a total inductance of 500 mH. When connected in series-opposing configuration, the coils have a total inductance of 300 mH. If the self-inductance of both the coils are equal, then the coupling coefficient is _____ (rounded off to two decimal places).

(GATE IN 2024)

64) The solution of an ordinary differential equation $y''' + 3y'' + 3y' + y = 30e^{-t}$ is

$$y(t) = \left(c_0 + c_1 t - c_2 t^2 + c_3 t^3\right) e^{-t}.$$

Given that $y(0) = 3$, $y'(0) = -3$, and $y''(0) = -47$, the value of $(c_0 + c_1 + c_2 + c_3)$ is _____ (rounded off to nearest integer). Note: $y''' = d^3y/dt^3, y'' = d^2y/dt^2, y' = dy/dt$ and c_0, c_1, c_2, c_3 are constants.

(GATE IN 2024)

65) A random variable X has a probability density function

$$f_X(x) = \begin{cases} e^{-x}, & x \geq 0 \\ 0, & \text{otherwise} \end{cases}$$

The probability of $X > 2$ is _____ (rounded off to three decimal places).

(GATE IN 2024)