## GENERAL APTITUDE

**Q. No. 1-5 Carry One Mark Each**

**1.** If ‘ $\rightarrow$ ’ denotes increasing order of intensity, then the meaning of the words [drizzle $\rightarrow$ rain $\rightarrow$ downpour] is analogous to [ ______ $\rightarrow$ quarrel $\rightarrow$ feud].
Which one of the given options is appropriate to fill the blank?

(A) bicker (B) bog (C) dither (D) dodge

**Key: (A)**

**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?

(A) Only I and II (B) Only II and III
(C) Only I and III (D) Only III

**Key: (B)**

**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

(A) 5 (B) $\sqrt{2}$ (C) 2 (D) $\sqrt{5}$

**Key: (D)**

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

(A) 1 (B) 20 (C) 2 (D) 1/2

**Key: (A)**

**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

(A) 150 (B) 200 (C) 250 (D) 175

**Key: (B)**

**Q. No. 6-10 Carry Two Marks Each**

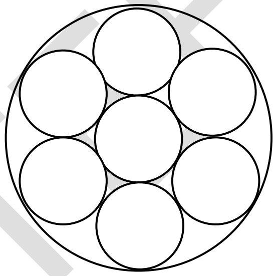
**6.** In the given text, the blanks are numbered (i)−(iv). Select the best match for all the blanks.

Yoko Roi stands __(i)____ as an author for standing ___(ii)___ as an honorary fellow, after she stood ___(iii)___ her writings that stand ___(iv)____ the freedom of speech.

(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

**Key: (D)**

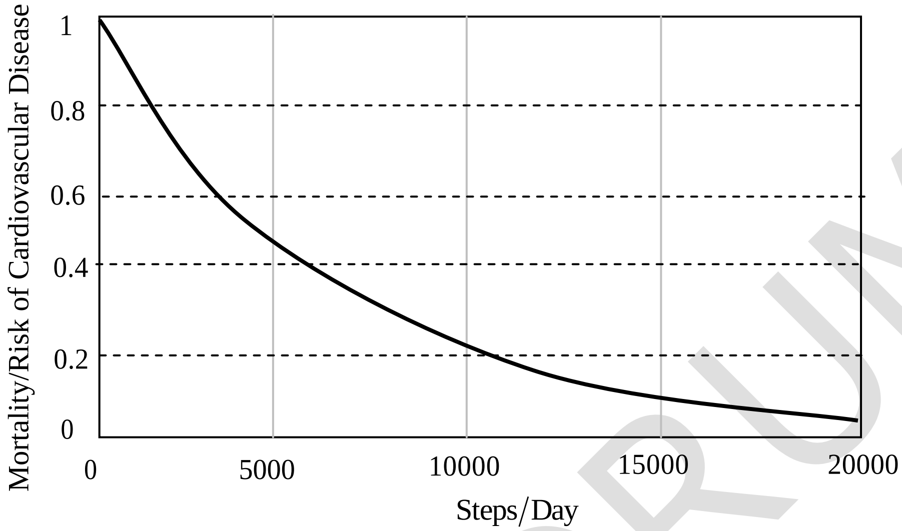
**7.** Seven identical cylindrical chalk-sticks are fitted tightly in a cylindrical container. The figure below shows the arrangement of the chalk-sticks inside the cylinder. The length of the container is equal to the length of the chalk-sticks. The ratio of the occupied space to the empty space of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



(A) 5/2 (B) 7/2 (C) 9/2 (D) 3

**Key: (B)**

**8.** The plot below 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?




(A) The risk reduction on increasing the steps/day from 0 to 10000 is less than the risk reduction on increasing the steps/day from 10000 to 20000.

(B) The risk reduction on increasing the steps/day from 0 to 5000 is less than the risk reduction on increasing the steps/day from 15000 to 20000.

(C) For any 5000 increment in steps/day the largest risk reduction occurs on going from 0 to 5000.

(D) For any 5000 increment in steps/day the largest risk reduction occurs on going from 15000 to 20000.

**Key:** **(C)**

**9.** Five cubes of identical size and another smaller cube are assembled as shown in Figure A. If viewed from direction X, the planar image of the assembly appears as Figure B.

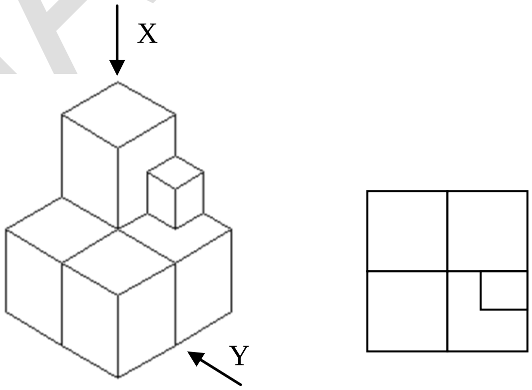
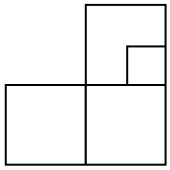


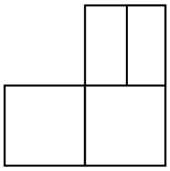

Figure A Figure B

If viewed from direction Y, the planar image of the assembly (Figure A) will appear as

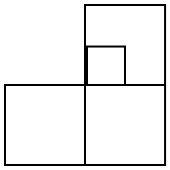
(A)



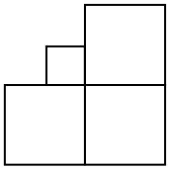
(B)



(C)



(D)



**Key: (A)**

**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

(A) 120° (B) 60° (C) 90° (D) 180°

**Key: (A)**

## INSTRUMENTATION ENGINEERING

**Q. No. 11-35 Carry One Mark Each**

**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

(A) parabola (B) hyperbola (C) ellipse (D) circle

**Key: (B)**

**12.** The pressure drop across a control valve is constant. The control valve with inherentcharacteristic has decreasing sensitivity. If $x$ represents the fraction of maximumstem position of the control valve, then the function $(x)$ representing the fractionof maximum flow is

(A) $\alpha^{x-1}$, where $\alpha$ is constant (B) $\sqrt{x}$

(C) x (D) $x^2$

**Key: (B)**

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

(A) 1 (B) 10 (C) 20 (D) 30

**Key: (D)**

**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 |

(A) (P) − (III), (Q) − (IV), (R) − (II), (S) − (I)

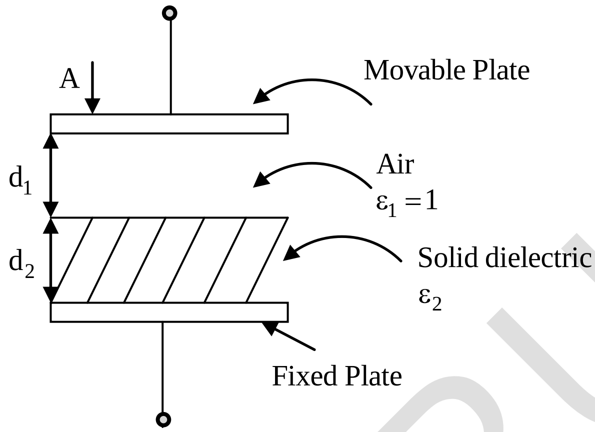
(B) (P) − (IV), (Q) − (III), (R) − (II), (S) − (I)

(C) (P) − (III), (Q) − (I), (R) − (IV), (S) − (II)

(D) (P) − (II), (Q) − (IV), (R) − (I), (S) − (III)

**Key: (A)**

**15.** The capacitor shown in the figure 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 permitivities are $\varepsilon_1$ and $\varepsilon_2$, respectively. Assume that the fringing field effects are negligible and $\varepsilon_0$ is the permittivity of free space.




If $d_1$ is decreased by $\delta d_1$, the resultant capacitance becomes

(A) $\dfrac{\varepsilon_0 A}{d_1 - \delta d_1 + \dfrac{d_2}{\varepsilon_2}}$ (B) $\dfrac{\varepsilon_0 A}{d_2 + \dfrac{d_1}{\varepsilon_2}}$

(C) $\dfrac{\varepsilon_0 A}{d_2 - \delta d_2 + \dfrac{d_1}{\varepsilon_2}}$ (D) $\dfrac{\varepsilon_0 A}{d_1 + \delta d_1 + \dfrac{d_2}{\varepsilon_2}}$

**Key: (A)**

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

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

**Key: (A)**

**17.** Consider the state-space representation of a system

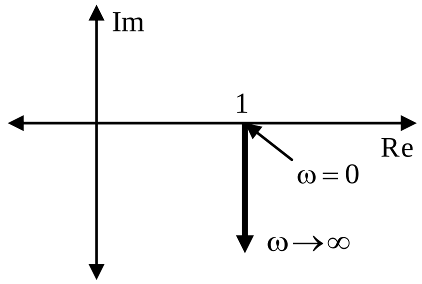
$\dot{x} = Ax + Bu$

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.

(A) $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ (B) $\begin{bmatrix} 1 & -1.5 \\ -2 & 3 \end{bmatrix}$ (C) $\begin{bmatrix} 1 & 1.5 \\ 2 & -3 \end{bmatrix}$ (D) $\begin{bmatrix} 0 & 1 \\ -2 & 3 \end{bmatrix}$

**Key: (B)**

**18.** The sinusoidal transfer function corresponding to the polar plot shown in the figure, for T > 0, is




(A) $1 - j\omega T$ (B) $\frac{1 - j\omega T}{1 + j\omega T}$ (C) $1 + j\omega T$ (D) $\frac{1}{1 + j\omega T}$

**Key: (A)**

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

$M = [v_1 \quad v_2 \quad v_3]$,

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

(A) $v_1 = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}, v_2 = \begin{bmatrix} 0 \\ -1 \\ 0 \end{bmatrix}, v_3 = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$

(B) $v_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, v_2 = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}, v_3 = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$

(C) $v_1 = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}, v_2 = \begin{bmatrix} -1 \\ 0 \\ 1 \end{bmatrix}, v_3 = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$

(D) $v_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix}, v_2 = \begin{bmatrix} -1 \\ 1 \\ -1 \end{bmatrix}, v_3 = \begin{bmatrix} 0 \\ -1 \\ 0 \end{bmatrix}$

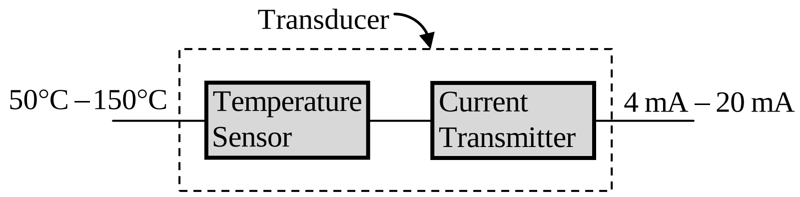
**Key: (C)**

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

(A) $4\pi \in \left(\frac{xy}{y - x}\right)$ (B) $4\pi \in \left(\frac{x^2}{y - x}\right)$ (C) $4\pi \in \left(\frac{y^2}{y - x}\right)$ (D) $4\pi \in \left(\frac{y^2 - xy}{x}\right)$

**Key: (A)**

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




**Key: (0.15 to 0.17)**

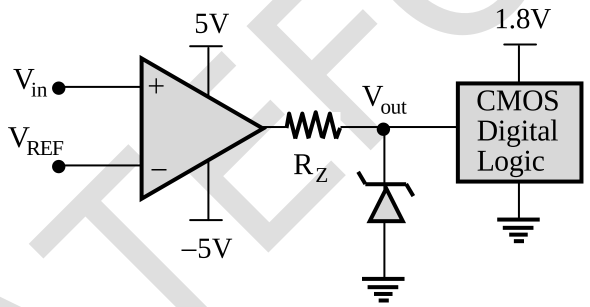
**22.** Consider a filter defined by the difference equation

$$y[n] - 0.5y[n-2] = ax[n-4]$$

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 $\left|H\left(\frac{\pi}{2}\right)\right| = 0.5,$ the value of a is _______ (rounded off to two decimal places).

**Key: (0.70 to 0.80)**

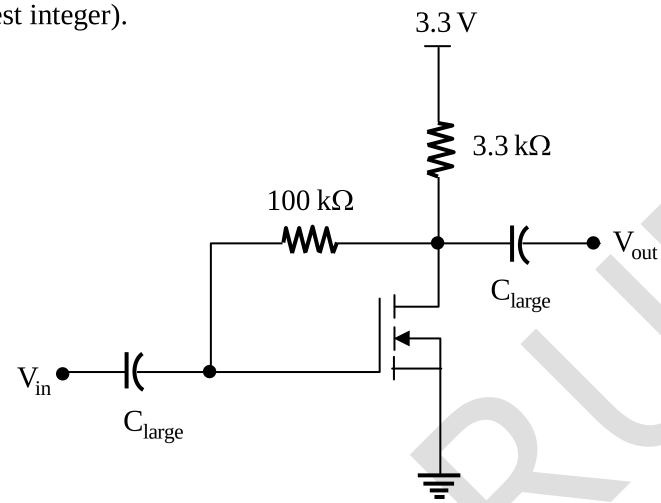
**23.** Consider the circuit shown in the figure.




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

**Key: (1.6)**

**24.** Figure shows an amplifier using an NMOS transistor. Assume that the transistor is in saturation with device parameters, $\mu_n C_{ox} = 250\,\mu A/V^2$, 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 __________ $\mu A$ (rounded off to nearest integer).




**Key:** **(498 to 502)**

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

**Key:** **(32)**

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

**Key:** **(–2)**

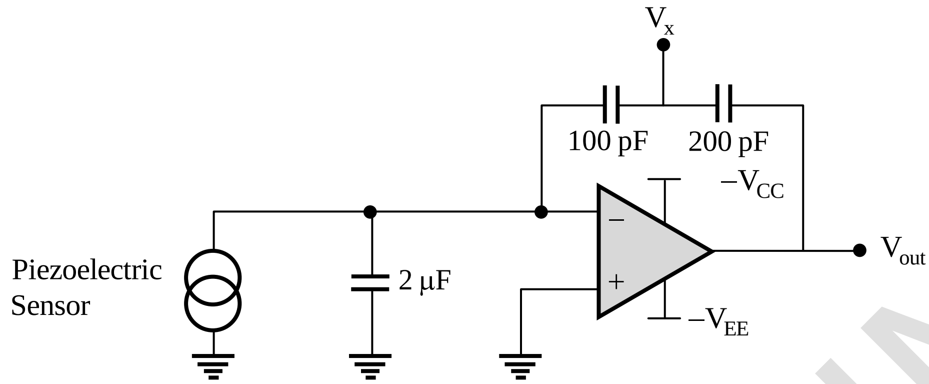
**27.** The Nyquist sampling frequency for $x(t) = 10\sin^2(200\pi t)$ is __________ Hz. (rounded off to nearest integer).

**Key:** **(400)**

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

**Key:** **(22)**

**29.** Consider the readout circuit of a piezoelectric sensor shown in the figure.




When the piezoelectric sensor generates a charge $q_p$, the resulting change in voltage $V_x$ is –2V. Then the corresponding change in the voltage $V_{out}$ is _______ V (rounded off to nearest integer).

**Key: (–3)**

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

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

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

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

**Key: (200)**

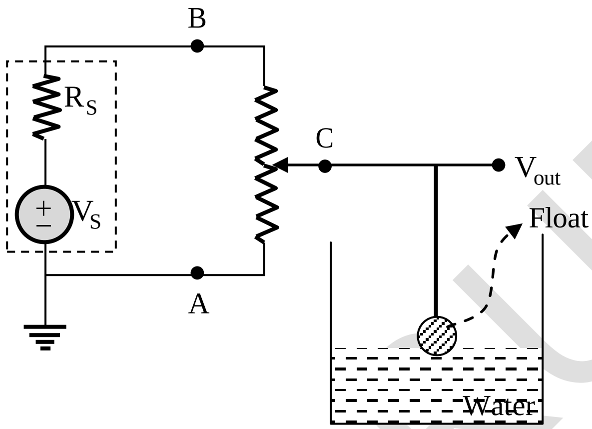
**31.** The current i(t) drawn by a circuit is given as

$i(t) = 4 + 30\cos(t) - 20\sin(t) + 15\cos(3t) - 10\sin(3t)\,A$

The root-mean-square value of $(t)$ is ________ A (rounded off to one decimalplace)

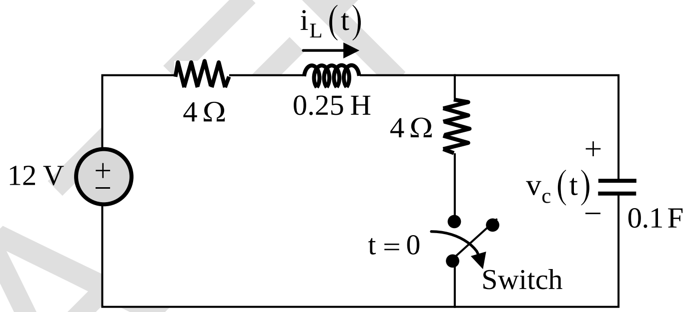
**Key: (27.0 to 30.0)**

**32.** A linear potentiometer $(0-10\,k\Omega)$ is used to measure the water level as shown in the figure. The resistance between A and C varies linearly from $0$ to $10\,k\Omega$ for a change in water level from 0 to 20 cm. The sensor is excited using a DC voltage source, $V_S = 10\,V$ with an internal resistance, $R_s = 200\,\Omega$. If $V_{out} = 5V$, the water level is _______ cm (rounded off to one decimal place).




**Key: (10.1 to 10.3)**

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




**Key: (15)**

**34.** Consider a system given by the following first order differentiable equation:

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

Where, $y(0) = 1$ and $0 \le t \le \infty$. 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).

**Key: (1.10 to 1.12)**

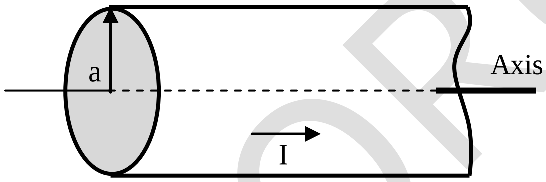
**35.** Indian Premier League has divided the sixteen cricket teams into two equal pools:Pool-A and Pool-B. Four teams of Pool-A have blue logo jerseys while the rest fourhave red logo jerseys. Five teams of Pool-B have blue logo jerseys while the restthree have red logo jerseys.

If one team from each pool reaches the final, the probability that one team has ablue logo jersey and another has a red logo jersey is ________ (rounded off to onedecimal place).

**Key: (0.5)**

**Q. No. 36-65 Carry Two Marks Each**

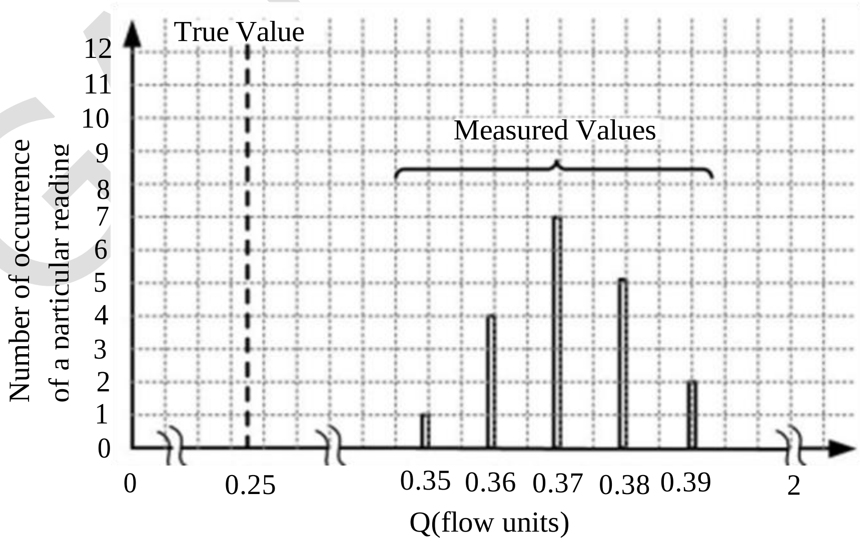
**36.** A wire circular cross section with radius a is shown in the figure. The current density is given by $J = ks^2$, where k is a constant, s is the radial distance from the axis and $0 \le s \le a$. The total current I in the wire is




(A) $\frac{\pi k a^4}{2}$ (B) $\frac{2\pi k a^3}{3}$ (C) $\frac{\pi k a^3}{2}$ (D) $\frac{\pi k a^4}{4}$

**Key: (A)**

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



(A) 0.12 and 0.14 (B) 0.01 and 0.10

(C) 0.10 and 0.14 (D) 0.04 and 0.12

**Key: (A)**

**38.** Consider a discrete-time sequence

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

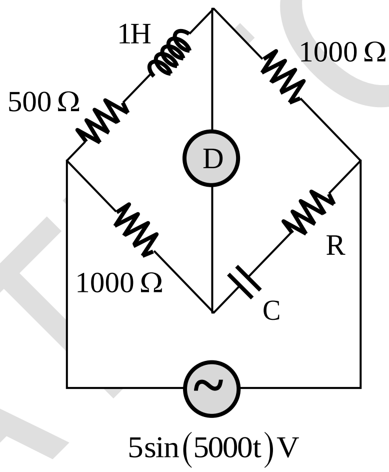
The region of convergence of X(Z), the z-transform of x[n], consists of

(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 $z = \infty$

**Key: (C)**

**39.** In the bridge circuit shown in the figure, under balanced condition, the values of Rand C respectively, are




(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 $2.02\,\mu F$

**Key: (C)**

**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 $-7 < \text{Re}\{S\} < -6$.

(A) $-e^{-6t}u(t)-e^{-7t}u(-t)$

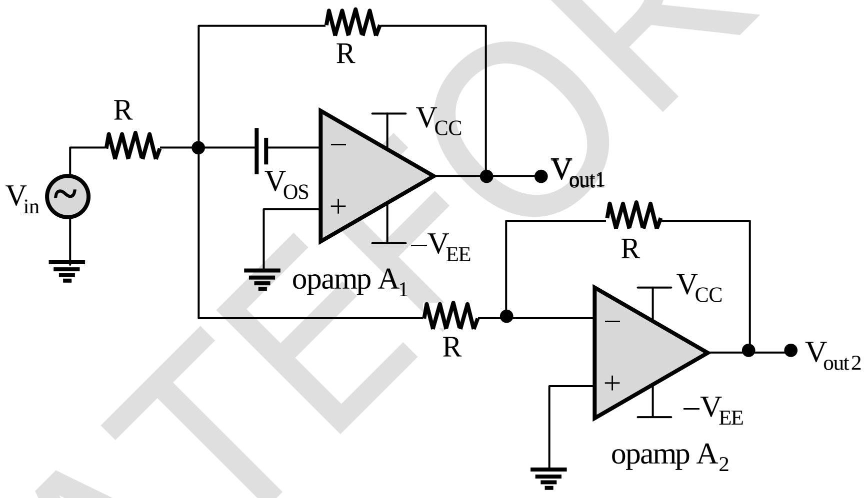
(B) $-e^{-6t}u(-t)-e^{-7t}u(t)$

(C) $e^{-6t}u(t)-e^{-7t}u(-t)$

(D) $-e^{-6t}u(-t)-e^{-7t}u(-t)$

**Key: (B)**

**41.** In the figure shown, both the opamps $A_1$ and $A_2$ are ideal, except that the opamp $A_1$ has an offset voltage $(V_{os})$ of 1mV. For $V_m = 0\,V$, the values of the output voltages $V_{out\,1}$ and $V_{out\,2}$, respectively, are




(A) 3 mV and −1 mV

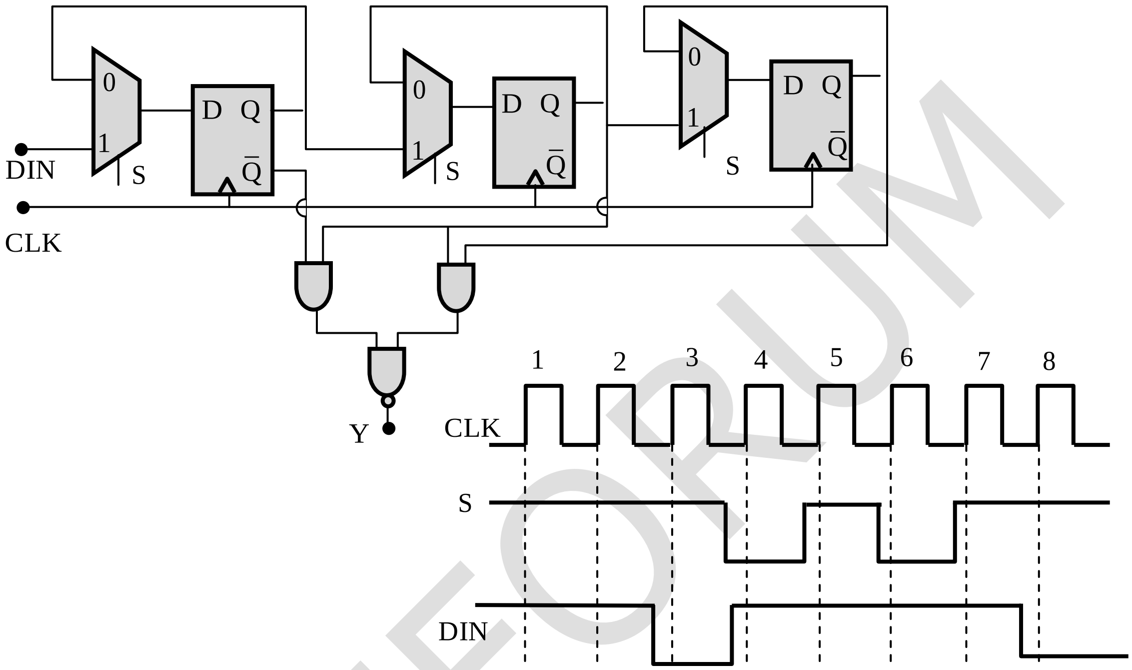
(B) 1 mV and 0 mV

(C) 1 mV and −1 mV

(D) 2 mV and 0 mV

**Key: (A)**

**42.** In the figure shown, 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 lock 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

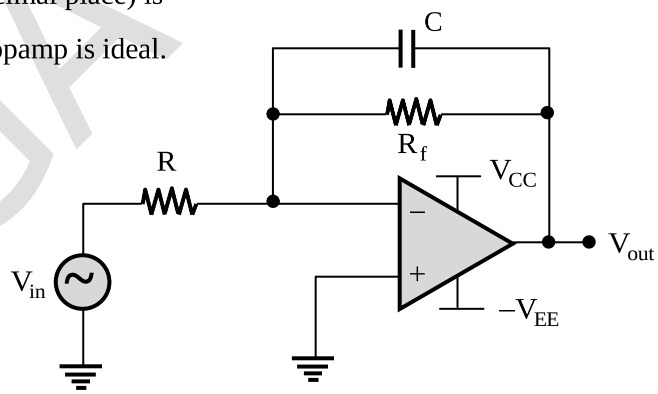



(A) 001 (B) 010 (C) 000 (D) 011

**Key: (A)**

**43.** In the figure shown, $R = 1\,k\Omega$ and $C = 0.1\,\mu F$. For a dc gain of –10, the 3 dB cut-off frequency (rounded off to one decimal place) is

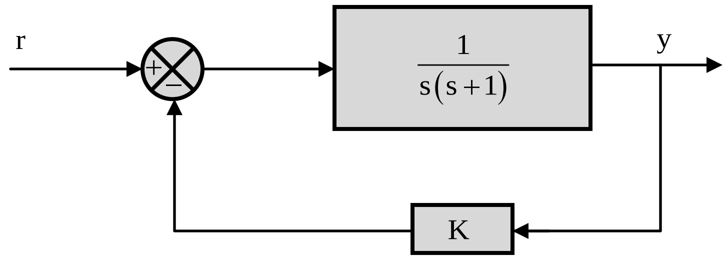
Assume the opamp is ideal.




(A) 159.1 Hz (B) 1591.5 Hz (C) 1750.7 Hz (D) 175.0 Hz

**Key: (A)**

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



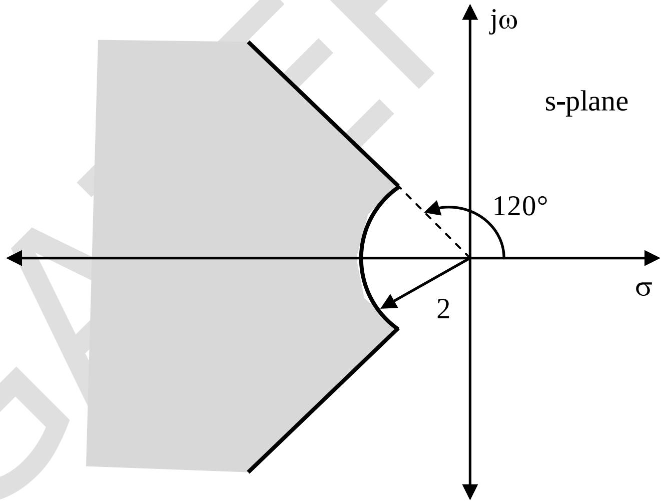

(A) $\frac{K-1}{K}$ (B) $\frac{1}{2}$ (C) 0 (D) $\frac{1-K}{K}$

**Key: (A)**

**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 $\xi$ and $\omega_n$ (in rad/s) from the following options such that the poles lie on the shaded region of the region of the s-plane shown in the figure.




(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 $\omega_n \geq \sqrt{3}$

**Key: (A)**

**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

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

is

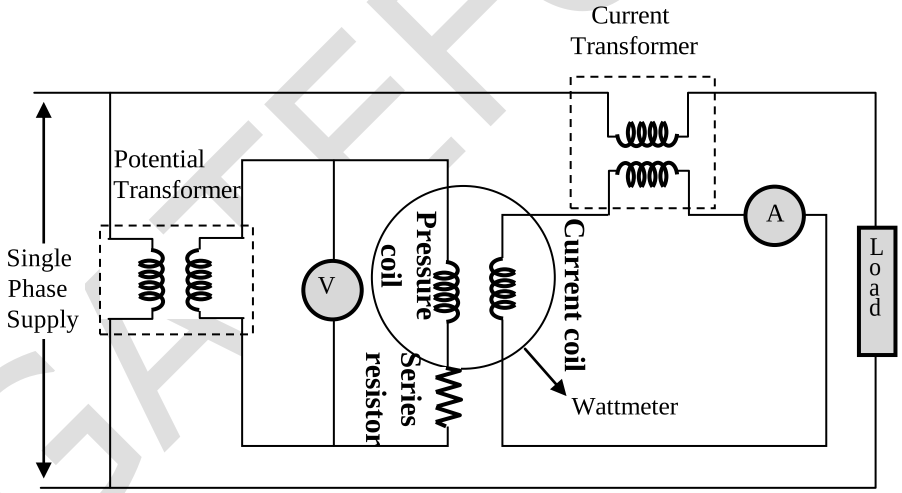
(A) $e^2 + 2e - 3$ (B) $e^2 - 2e - 3$ (C) $e^2 + e - 1$ (D) $e^2 + e + 1$

**Key: (A)**

**47.** In the figure shown , assume

- $\alpha$ is the phase angle between the load current and the load voltage.
- $\beta$ is the phase angle by which pressure coil current lags the pressure coil voltage of the wattmeter
- $\gamma$ is the phase angle between currents in the pressure coil and the current coil of the wattmeter
- $\delta$ is the phase angle of the voltage transformer
- $\theta$ is the phase angle of the current transformer

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



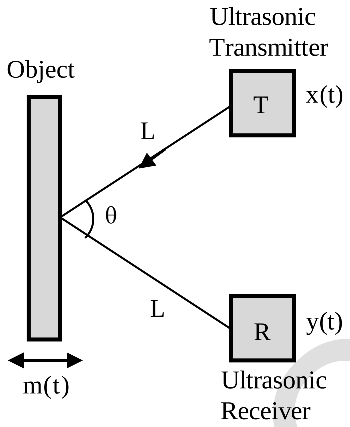

(A) $\alpha = -\gamma \pm \delta \pm \theta - \beta$ (B) $\alpha = -\gamma \pm \delta \pm \theta + \beta$

(C) $\alpha = \gamma \pm \delta \pm \theta + \beta$ (D) $\alpha = \gamma \pm \delta \pm \theta - \beta$

**Key: (C)**

**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 $y(t)=\cos(2\pi f_1 t+\beta\cos(2\pi f_2 t))$ volts.

Assume that frequency sensitivity factor as 500 Hz/volt, $f_1 = 40\text{ kHz}, f_2 = 1\text{ kHz}$, the modulation index $(\beta)$ and the frequency deviation in y(t), respectively, are




(A) 0.25 and ±250 Hz
(B) 0.5 and ±500 Hz
(C) 1 and ±1000 Hz
(D) 0.75 and ±1000 Hz

**Key: (A)**

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

(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) $\frac{df(z)}{dz}\neq 0$

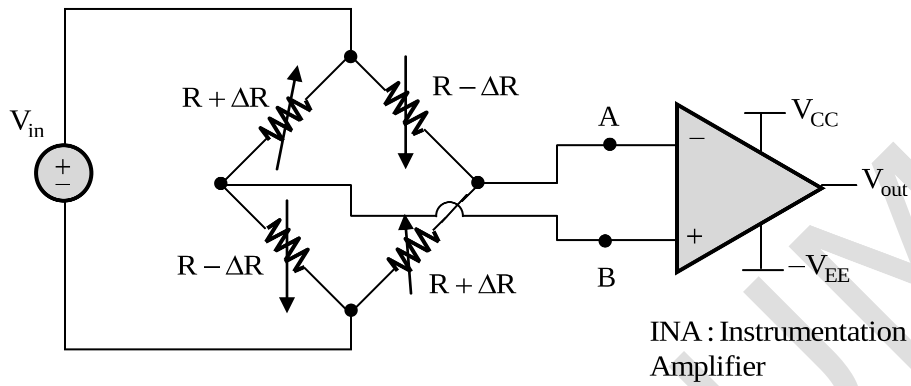
**Key: (A,C)**

**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 |

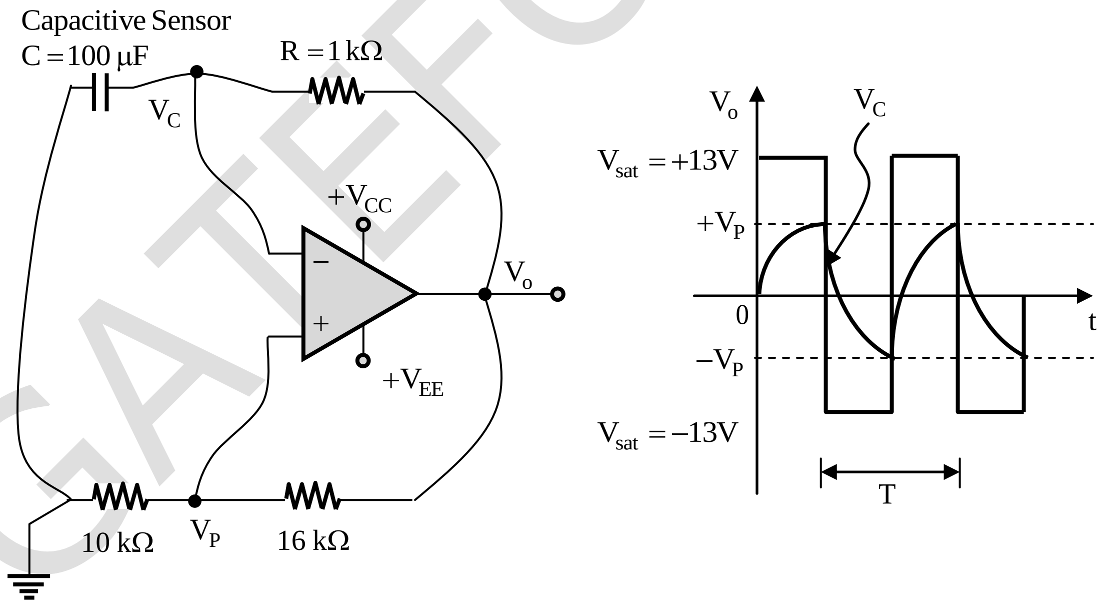
**Key: (0.5)**

**51.** In the figure shown, $R = 4.5\,k\Omega$, $\Delta R = 1.5\,k\Omega$ and INA is assumed to be ideal. The equivalent resistance between A and B is __________ $k\Omega$ (rounded off to nearest integer).




**Key: (4)**

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




**Key: (6.0 to 6.3)**

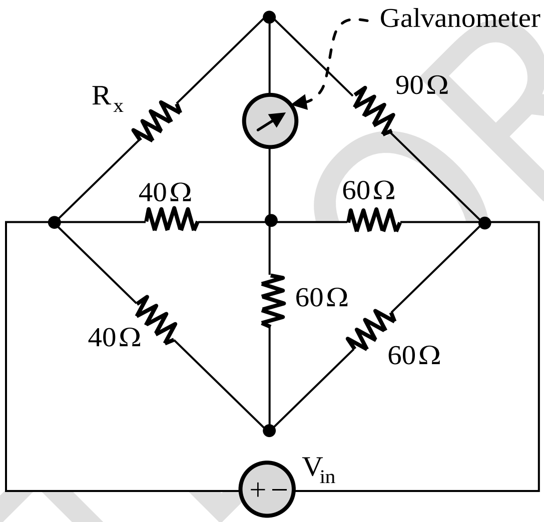
**53.** The 4-point DFTs of two sequences $x[n]$ and $y[n]$ are $X=[k]=[1,-j,1,j]$ and $Y[k]=[1,3j,1,-3j]$, respectively. Assuming z[n] represents the 4-piont circuit convolution of x[n] and y[n], the value of z[0] is __________ (rounded off to nearest integer).

Note: The DFT of a N-point sequence x[n] is defined as

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

**Key: (2)**

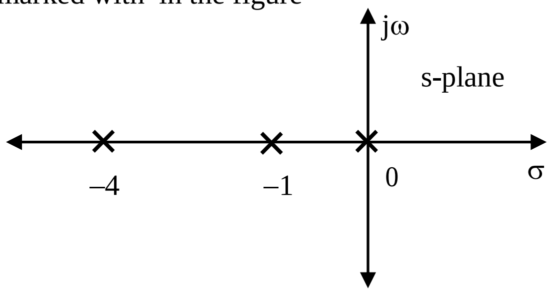
**54.** Consider the figure shown. For zero deflection in the galvanometer, the required value of resistor $R_x$ is __________ $\Omega$ (rounded off to nearest integer).




**Key: (60)**

**55.** Consider a unity negative feedback system with its open-loop pole-zero map as shown in the figure. If the point $s=j\theta, \alpha>0$, lies on the root locus, the value of $\alpha$ is _________ (rounded off to nearest integer).

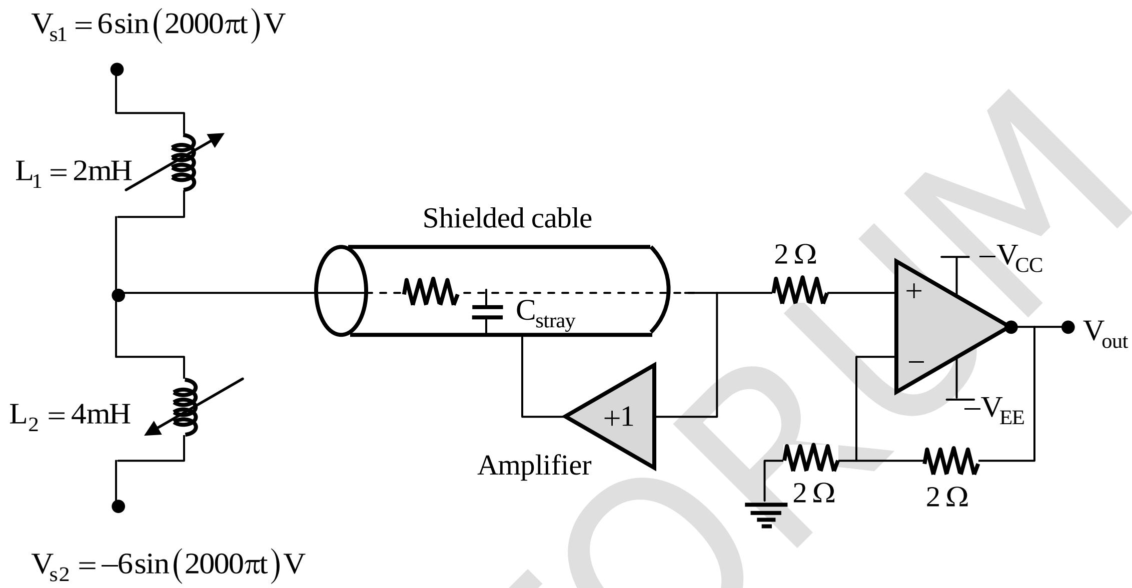
**Note:** The poles are marked with  in the figure




**Key: (2)**

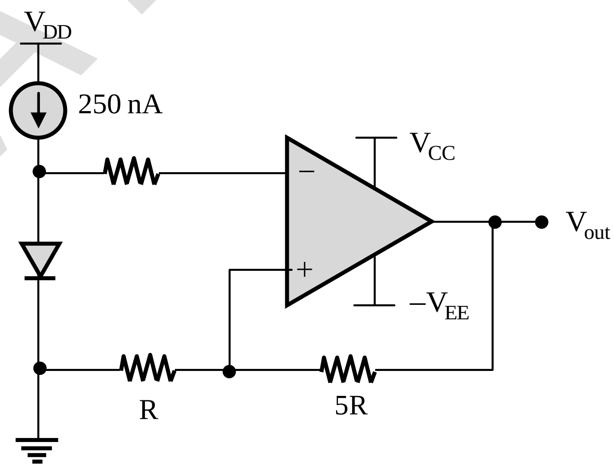
**56.** A shielded cable with $C_{stray} = 20\,pF$ and $R_{wire} = 10\,\Omega$ is sued to connect the inductive sensors as shown in the figure. The RMS value of $V_{out}$ is ________V (rounded off to two decimal places).

Note: Assume all components are ideal, and sensors are not magnetically coupled.




**Key: (2.83)**

**57.** In the figure shown, the diode current is given by $I_D = I_S e^{\frac{\alpha V_D}{T}}$. $V_D$ 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 output voltage $(V_{out})$ per Kelvin change in temperature is _________ mV (rounded off to one decimal place).

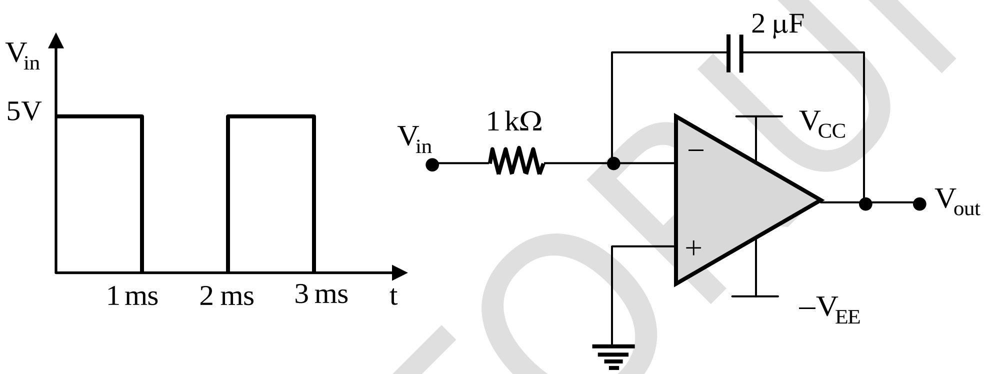



**Key: (10)**

**58.** A ADC has a full scale voltage of 1.4V, resolution of 200mV, 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).

**Key: (3)**

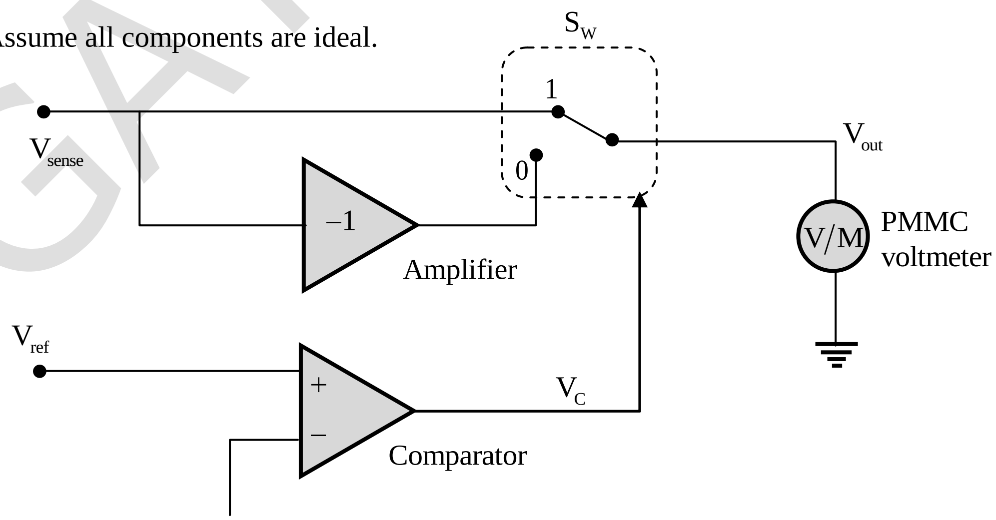
**59.** In the circuit shown, assume the opamp is ideal and the initial charge on the capacitor is zero. The output voltage at time t = 2 ms is _________ V (rounded off to one decimal place).




**Key: (-2.5)**

**60.** In the figure shown, $S_W$ 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.




**Key: (0)**

**61.** A 50 kVA 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% ofthe full load and 0.8 power factor is ________% (rounded off to one decimalplace)

**Key: (95.3)**

**62.** A three-phase squirrel-cage induction motor has a starting torque of 100% of thefull load torque and a maximum torque of 300% of the full load torque. Neglectingthe stator impedance, the slip at the maximum torque is ________% (rounded offto two decimal places).

**Key: (17.2)**

**63.** Two magnetically coupled coils, when connected in series-aiding configuration,have a total inductance of 500 mH. When connected in series-opposingconfiguration, the coils have a total inductance of 300 mH. If the self-inductance ofboth the coils are equal, then the coupling coefficient is ________ (rounded off totwo decimal places).

**Key: (0.25)**

**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 $y(0) = 3, y'(0) = -3$ and $y''(0) = -47$, the value of $(c_0 + c_1 + c_2 + c_3)$ is _________ (rounded off to nearest integer).

Note: $y''' = \frac{d^3y}{dt^3}, y'' = \frac{d^2y}{dt^2}, y' = \frac{dy}{dt}$ and $c_0, c_1, c_2, c_3$ are constants.

**Key: (33)**

**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).

**Key: (0.135)**

★★★