

**Q. 1 – Q. 5 carry one mark each.**

Q.1 An apple costs Rs. 10. An onion costs Rs. 8.

Select the most suitable sentence with respect to grammar and usage.

- (A) The price of an apple is greater than an onion.
- (B) The price of an apple is more than onion.
- (C) The price of an apple is greater than that of an onion.
- (D) Apples are more costlier than onions.

Q.2 The Buddha said, "Holding on to anger is like grasping a hot coal with the intent of throwing it at someone else; you are the one who gets burnt."

Select the word below which is closest in meaning to the word underlined above.

- (A) burning
- (B) igniting
- (C) clutching
- (D) flinging

Q.3 M has a son Q and a daughter R. He has no other children. E is the mother of P and daughter-in-law of M. How is P related to M?

- (A) P is the son-in-law of M.
- (B) P is the grandchild of M.
- (C) P is the daughter-in law of M.
- (D) P is the grandfather of M.

Q.4 The number that least fits this set: (324, 441, 97 and 64) is \_\_\_\_\_.

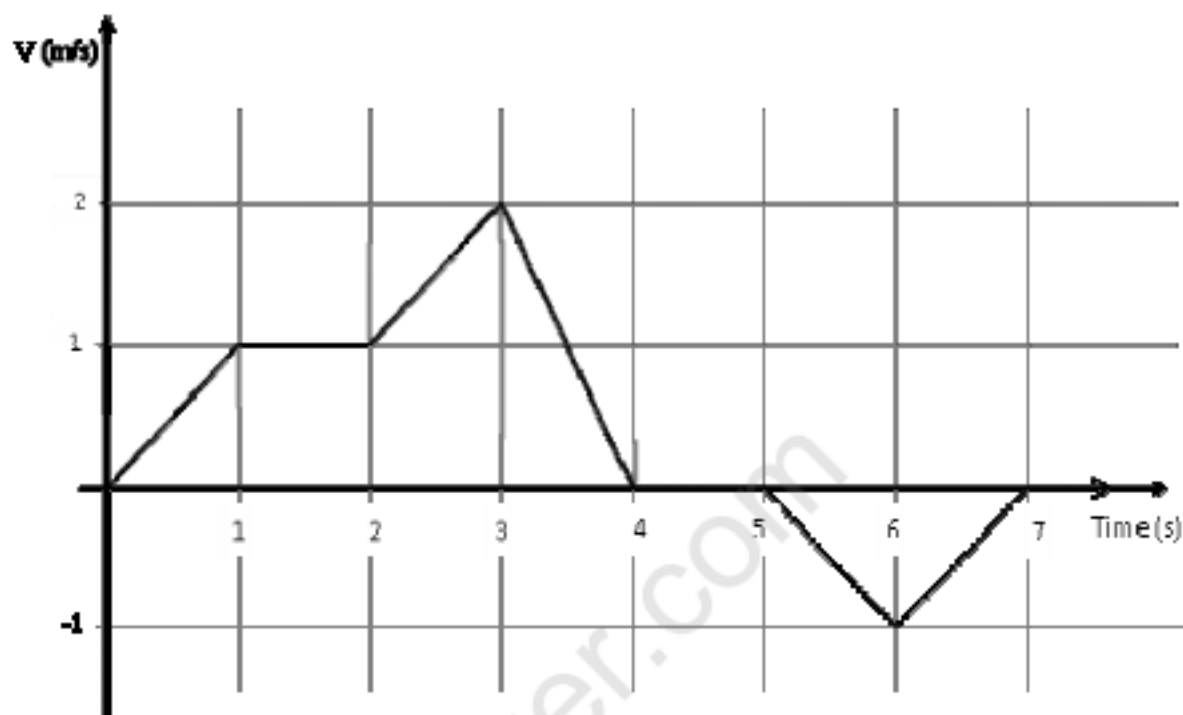
- (A) 324
- (B) 441
- (C) 97
- (D) 64

Q.5 It takes 10 s and 15 s, respectively, for two trains travelling at different constant speeds to completely pass a telegraph post. The length of the first train is 120 m and that of the second train is 150 m. The magnitude of the difference in the speeds of the two trains (in m/s) is \_\_\_\_\_.

- (A) 2.0
- (B) 10.0
- (C) 12.0
- (D) 22.0

**Q. 6 – Q. 10 carry two marks each.**

- Q.6 The velocity  $V$  of a vehicle along a straight line is measured in m/s and plotted as shown with respect to time in seconds. At the end of the 7 seconds, how much will the odometer reading increase by (in m)?



- (A) 0                      (B) 3                      (C) 4                      (D) 5
- Q.7 The overwhelming number of people infected with rabies in India has been flagged by the World Health Organization as a source of concern. It is estimated that inoculating 70% of pets and stray dogs against rabies can lead to a significant reduction in the number of people infected with rabies.
- Which of the following can be logically inferred from the above sentences?
- (A) The number of people in India infected with rabies is high.
- (B) The number of people in other parts of the world who are infected with rabies is low.
- (C) Rabies can be eradicated in India by vaccinating 70% of stray dogs.
- (D) Stray dogs are the main source of rabies worldwide.
- Q.8 A flat is shared by four first year undergraduate students. They agreed to allow the oldest of them to enjoy some extra space in the flat. Manu is two months older than Sravan, who is three months younger than Trideep. Pavan is one month older than Sravan. Who should occupy the extra space in the flat?
- (A) Manu                      (B) Sravan                      (C) Trideep                      (D) Pavan
- Q.9 Find the area bounded by the lines  $3x+2y=14$ ,  $2x-3y=5$  in the first quadrant.
- (A) 14.95                      (B) 15.25                      (C) 15.70                      (D) 20.35



Q.10 A straight line is fit to a data set  $(\ln x, y)$ . This line intercepts the abscissa at  $\ln x = 0.1$  and has a slope of  $-0.02$ . What is the value of  $y$  at  $x = 5$  from the fit?

(A)  $-0.030$ (B)  $-0.014$ (C)  $0.014$ (D)  $0.030$ 

**END OF THE QUESTION PAPER**

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**Q. 1 – Q. 25 carry one mark each.**

Q.1 A straight line of the form  $y = mx + c$  passes through the origin and the point  $(x, y) = (2, 6)$ . The value of  $m$  is \_\_\_\_\_.

Q.2  $\lim_{n \rightarrow \infty} (\sqrt{n^2 + n} - \sqrt{n^2 + 1})$  is \_\_\_\_\_.

Q.3 A voltage  $V_1$  is measured 100 times and its average and standard deviation are 100 V and 1.5 V respectively. A second voltage  $V_2$ , which is independent of  $V_1$ , is measured 200 times and its average and standard deviation are 150 V and 2 V respectively.  $V_3$  is computed as:  $V_3 = V_1 + V_2$ . Then the standard deviation of  $V_3$  in volt is \_\_\_\_\_.

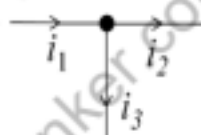
Q.4 The vector that is **NOT** perpendicular to the vectors  $(i + j + k)$  and  $(i + 2j + 3k)$  is \_\_\_\_\_.

(A)  $(i - 2j + k)$  (B)  $(-i + 2j - k)$  (C)  $(0i + 0j + 0k)$  (D)  $(4i + 3j + 5k)$

Q.5 In the neighborhood of  $z = 1$ , the function  $f(z)$  has a power series expansion of the form  $f(z) = 1 + (1 - z) + (1 - z)^2 + \dots$ . Then  $f(z)$  is

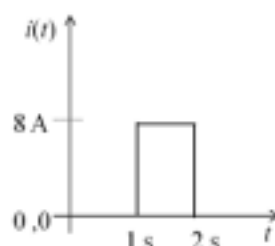
(A)  $\frac{1}{z}$  (B)  $\frac{-1}{z-2}$  (C)  $\frac{z-1}{z+1}$  (D)  $\frac{1}{2z-1}$

Q.6 Three currents  $i_1$ ,  $i_2$  and  $i_3$  meet at a node as shown in the figure below. If  $i_1 = 3 \cos(\omega t)$  ampere,  $i_2 = 4 \sin(\omega t)$  ampere and  $i_3 = I_3 \cos(\omega t + \theta)$  ampere, the value of  $I_3$  in ampere is \_\_\_\_\_.

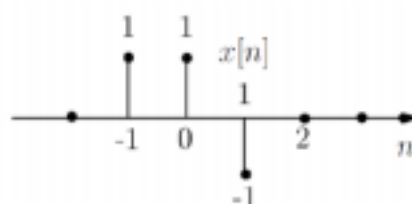


Q.7 An air cored coil has a Q of 5 at a frequency of 100 kHz. The Q of the coil at 20 kHz (neglecting skin effect) will be \_\_\_\_\_.

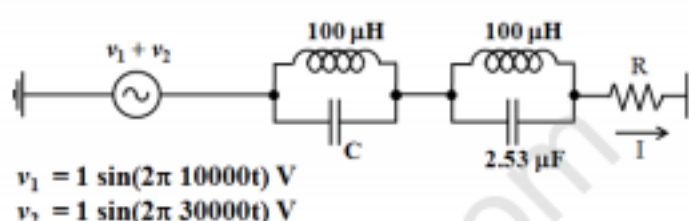
Q.8 A current  $i(t)$  shown in the figure below is passed through a 1 F capacitor that had zero initial charge. The voltage across the capacitor for  $t > 2$  s in volt is \_\_\_\_\_.



- Q.9 The signal  $x[n]$  shown in the figure below is convolved with itself to get  $y[n]$ . The value of  $y[-1]$  is \_\_\_\_\_.



- Q.10 In the circuit shown below  $(v_1 + v_2) = [1 \sin(2\pi 10000t) + 1 \sin(2\pi 30000t)]$  V. The RMS value of the current through the resistor R will be minimum if the value of the capacitor C in **microfarad** is \_\_\_\_\_.



- Q.11 If  $X(s)$ , the Laplace transform of signal  $x(t)$  is given by  $X(s) = \frac{(s+2)}{(s+1)(s+3)^2}$ , then the value of  $x(t)$  as  $t \rightarrow \infty$  is \_\_\_\_\_.

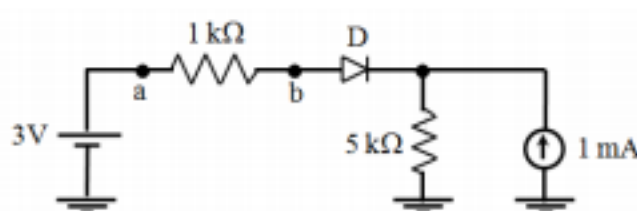
- Q.12 The number of times the Nyquist plot of  $G(s) = \frac{s-1}{s+1}$  will encircle the origin clockwise is \_\_\_\_\_.

- Q.13 The value of  $a_0$  which will ensure that the polynomial  $s^3 + 3s^2 + 2s + a_0$  has roots on the left half of the  $s$ -plane is

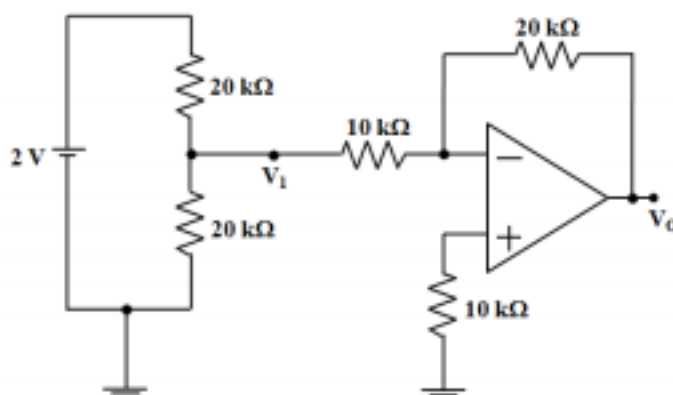
(A) 11                      (B) 9                      (C) 7                      (D) 5

- Q.14 The input  $i(t) = 2 \sin(3t + \pi)$  is applied to a system whose transfer function  $G(s) = \frac{8}{(s+10)^2}$ . The amplitude of the output of the system is \_\_\_\_\_.

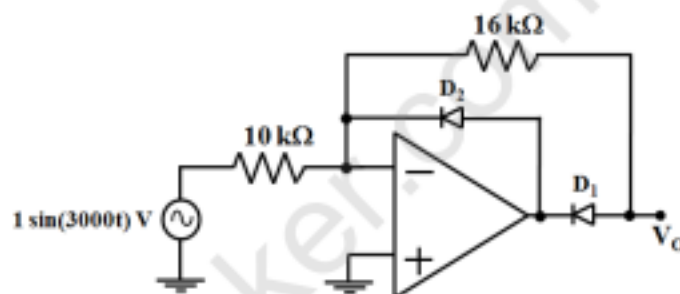
- Q.15 The diode D used in the circuit below is ideal. The voltage drop  $V_{ab}$  across the 1 kΩ resistor in **volt** is \_\_\_\_\_.



Q.16 In the circuit given below, the opamp is ideal. The output voltage  $V_O$  in volt is \_\_\_\_.



Q.17 In the circuit given below, the diodes  $D_1$  and  $D_2$  have a forward voltage drop of 0.6 V. The opamp used is ideal. The **magnitude** of the negative peak value of the output  $V_O$  in volt is \_\_\_\_\_.



Q.18 The Boolean expression  $XY + (X' + Y')Z$  is equivalent to

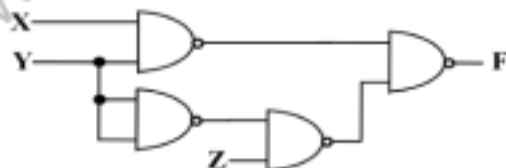
(A)  $XYZ' + X'Y'Z$

(B)  $X'Y'Z' + XYZ$

(C)  $(X + Z)(Y + Z)$

(D)  $(X' + Z)(Y' + Z)$

Q.19 In the digital circuit given below,  $F$  is



(A)  $XY + Y\bar{Z}$

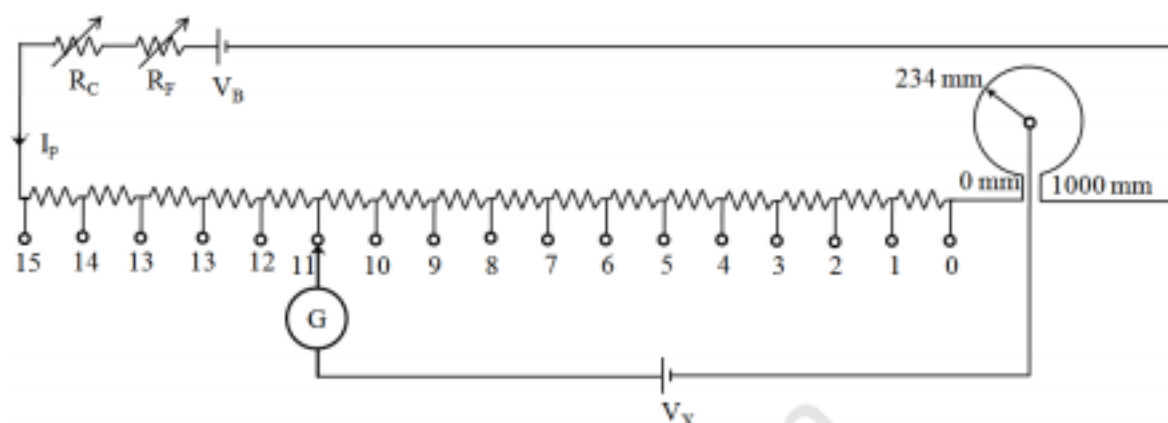
(B)  $XY + \bar{Y}Z$

(C)  $\bar{X}\bar{Y} + Y\bar{Z}$

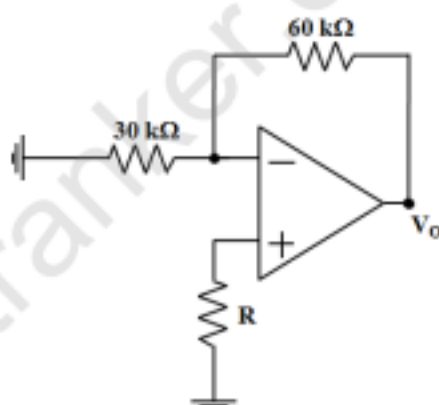
(D)  $XZ + \bar{Y}$

Q.20 A  $3\frac{1}{2}$  digit DMM has an accuracy specification of  $\pm 1\%$  of full scale (accuracy class 1). A reading of 100.0 mA is obtained on its 200 mA full scale range. The worst case error in the reading in milliamperes is  $\pm$  \_\_\_\_\_.

- Q.21 A dc potentiometer, shown in figure below, is made by connecting fifteen  $10\ \Omega$  resistors and a  $10\ \Omega$  slide wire of length  $1000\text{ mm}$  in series. The potentiometer is standardized with the current  $I_p = 10.0000\text{ mA}$ . Balance for an unknown voltage is obtained when the dial is in position 11 (11 numbers of the fixed  $10\ \Omega$  resistor are included) and the slide wire is on the  $234\text{th mm}$  position. The unknown voltage (up to four decimal places) in **volt** is \_\_\_\_\_.



- Q.22 In the circuit given below, each input terminal of the opamp draws a bias current of  $10\text{ nA}$ . The effect due to these input bias currents on the output voltage  $V_O$  will be zero, if the value of  $R$  chosen in **kilo-ohm** is \_\_\_\_\_.



- Q.23 A piezo-electric type pressure sensor has a sensitivity of  $1\text{ mV/kPa}$  and a bandwidth of  $300\text{ Hz}$  to  $300\text{ kHz}$ . For a constant (dc) pressure of  $100\text{ kPa}$ , the steady state output of the sensor in **mV** is \_\_\_\_\_.
- Q.24 The signal  $m(t) = \cos(\omega_m t)$  is SSB (single side-band) modulated with a carrier  $\cos(\omega_c t)$  to get  $s(t)$ . The signal obtained by passing  $s(t)$  through an ideal envelope detector is
- (A)  $\cos(\omega_m t)$  (B)  $\sin(\omega_m t)$   
(C)  $\cos(\omega_m t) + \sin(\omega_m t)$  (D) 1



- Q.25 Let  $s(t) = \text{rect}\left(\frac{t-3}{3}\right)$  be a signal passed through an AWGN (additive white Gaussian noise) channel with noise power spectral density (PSD)  $\frac{N_0}{2}$  to get  $v(t)$ . If  $v(t)$  is passed through a matched-filter that is matched to  $s(t)$ , then output signal-to noise ratio (SNR) of the matched-filter is
- (A)  $\frac{1}{N_0}$                       (B)  $\frac{2}{N_0}$                       (C)  $\frac{3}{N_0}$                       (D)  $\frac{4}{N_0}$

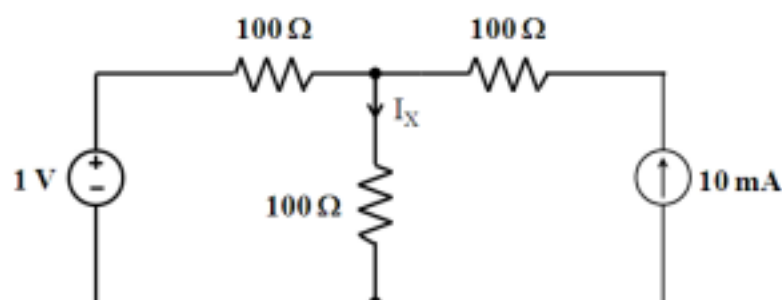
**Q. 26 – Q. 55 carry two marks each.**

- Q.26 Let  $f: [-1, 1] \rightarrow \mathbb{R}$ , where  $f(x) = 2x^3 - x^4 - 10$ . The minimum value of  $f(x)$  is \_\_\_\_\_.
- Q.27 An urn contains 5 red and 7 green balls. A ball is drawn at random and its colour is noted. The ball is placed back into the urn along with another ball of the same colour. The probability of getting a red ball in the next draw is
- (A)  $\frac{65}{156}$                       (B)  $\frac{67}{156}$                       (C)  $\frac{79}{156}$                       (D)  $\frac{89}{156}$
- Q.28 Consider the matrix  $A = \begin{pmatrix} 2 & 1 & 1 \\ 2 & 3 & 4 \\ -1 & -1 & -2 \end{pmatrix}$  whose eigenvalues are 1, -1 and 3. Then Trace of  $(A^3 - 3A^2)$  is \_\_\_\_\_.
- Q.29 The relationship between the force  $f(t)$  and the displacement  $x(t)$  of a spring-mass system (with a mass  $M$ , viscous damping  $D$  and spring constant  $K$ ) is
- $$M \frac{d^2 x(t)}{dt^2} + D \frac{dx(t)}{dt} + Kx(t) = f(t).$$
- $X(s)$  and  $F(s)$  are the Laplace transforms of  $x(t)$  and  $f(t)$  respectively. With  $M = 0.1$ ,  $D = 2$ ,  $K = 10$  in appropriate units, the transfer function  $G(s) = \frac{X(s)}{F(s)}$  is
- (A)  $\frac{10}{s^2 + 20s + 100}$                       (B)  $s^2 + 20s + 100$                       (C)  $\frac{10s^2}{s^2 + 20s + 100}$                       (D)  $\frac{s}{s^2 + 20s + 100}$

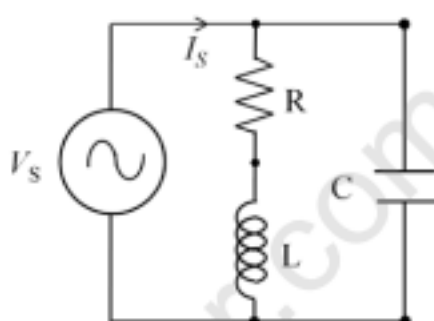
- Q.30 The value of the integral  $\frac{1}{2\pi j} \int_C \frac{z^2 + 1}{z^2 - 1} dz$  where  $z$  is a complex number and  $C$  is a unit circle with center at  $1 + 0j$  in the complex plane is \_\_\_\_\_.



Q.31 The current  $I_X$  in the circuit given below in **milliampere** is \_\_\_\_\_.

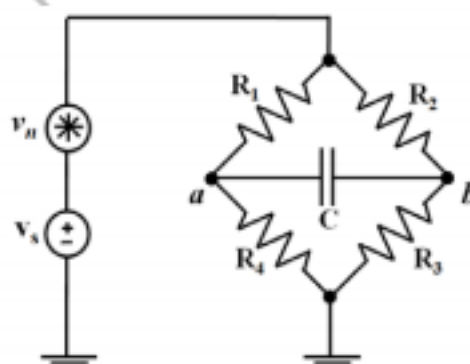


Q.32 In the circuit shown below,  $V_S = 101\angle 0^\circ \text{ V}$ ,  $R = 10\ \Omega$  and  $\omega L = 100\ \Omega$ . The current  $I_S$  is in phase with  $V_S$ . The magnitude of  $I_S$  in **milliampere** is \_\_\_\_\_.

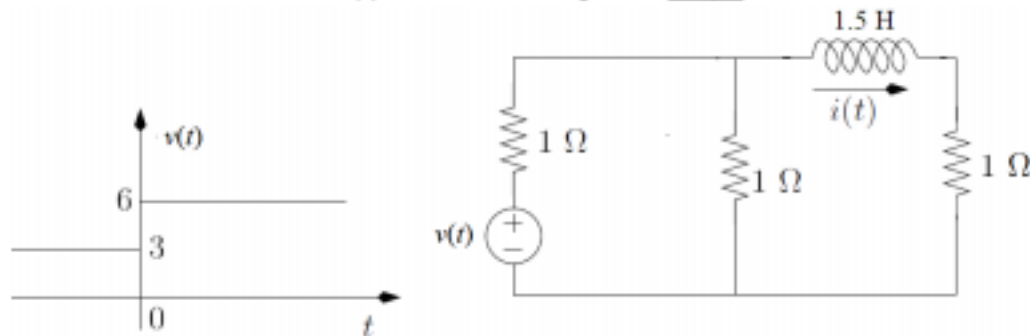


Q.33 A symmetrical three-phase three-wire RYB system is connected to a balanced delta-connected load. The RMS values of the line current and line-to-line voltage are 10 A and 400 V respectively. The power in the system is measured using the two wattmeter method. The first wattmeter connected between R-line and Y-line reads zero. The reading of the second wattmeter (connected between B-line and Y-line) in **watt** is \_\_\_\_\_.

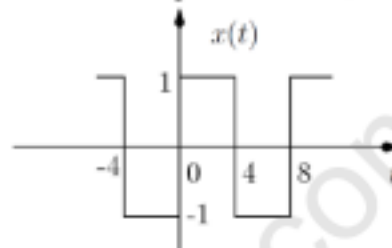
Q.34 In the strain gauge bridge circuit given below,  $R_1 = R_3 = R(1 - x)$  and  $R_2 = R_4 = R(1 + x)$ , where  $R$  is  $350\ \Omega$ . The voltage sources  $v_n$  and  $v_s$  represent the dc excitation and the undesired noise/interference, respectively. The value of capacitor  $C$  in **microfarad** that is required to ensure that the output across  $a$  and  $b$  is low-pass filtered with a cutoff frequency of 150 Hz is \_\_\_\_\_.



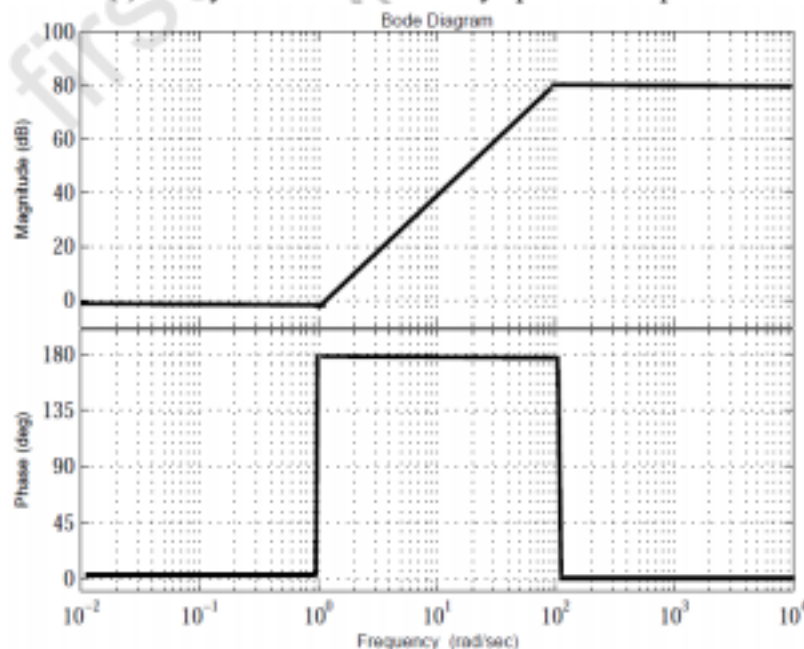
- Q.35 The voltage  $v(t)$  shown below is applied to the given circuit.  $v(t) = 3\text{ V}$  for  $t < 0$  and  $v(t) = 6\text{ V}$  for  $t > 0$ . The value of current  $i(t)$  at  $t = 1\text{ s}$ , in ampere is \_\_\_\_\_.



- Q.36 For the periodic signal  $x(t)$  shown below with period  $T = 8\text{ s}$ , the power in the  $10^{\text{th}}$  harmonic is

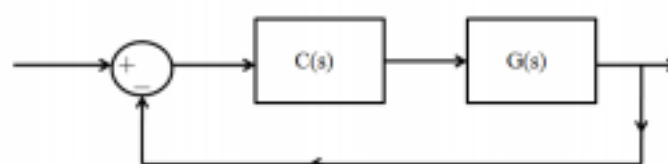


- (A) 0      (B)  $\frac{1}{2} \left( \frac{2}{10\pi} \right)^2$       (C)  $\frac{1}{2} \left( \frac{4}{10\pi} \right)^2$       (D)  $\frac{1}{2} \left( \frac{4}{5\pi} \right)^2$
- Q.37 The fundamental period  $N_0$  of the discrete-time sinusoid  $x[n] = \sin\left(\frac{301}{4}\pi n\right)$  is \_\_\_\_\_.
- Q.38 The transfer function  $G(s)$  of a system which has the asymptotic Bode plot shown below is



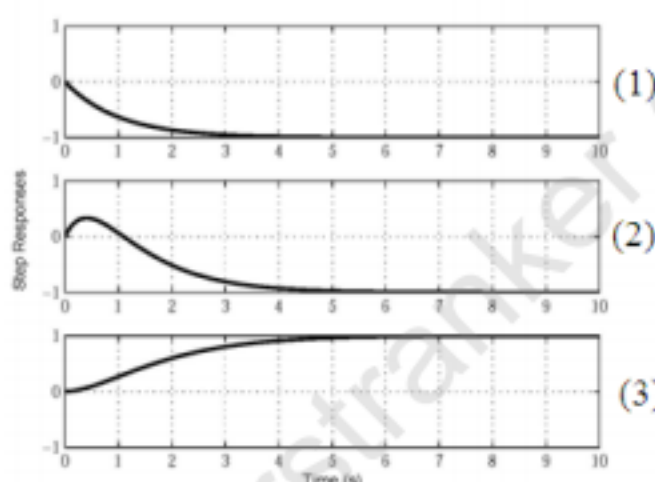
- (A)  $10^4 \frac{(s-1)^2}{(s+100)^2}$       (B)  $10^4 \frac{(s+1)^2}{(s+100)^2}$       (C)  $10^4 \frac{(s+1)}{(s+100)^2}$       (D)  $10^4 \frac{(s-1)^2}{(s-100)^2}$

- Q.39 For the feedback system given below, the transfer function  $G(s) = \frac{1}{(s+1)^2}$ . The system **CANNOT** be stabilized with



- (A)  $C(s) = 1 + \frac{3}{s}$                       (B)  $C(s) = 3 + \frac{7}{s}$   
 (C)  $C(s) = 3 + \frac{9}{s}$                       (D)  $C(s) = \frac{1}{s}$

- Q.40 Match the unit-step responses (1), (2) and (3) with the transfer functions P(s), Q(s) and R(s), given below.



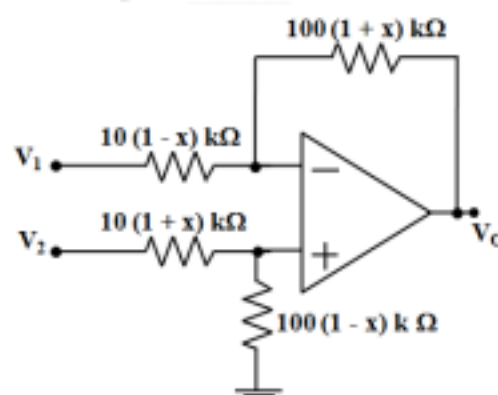
$$P(s) = \frac{-1}{(s+1)}$$

$$Q(s) = \frac{2(s-1)}{(s+10)(s+2)}$$

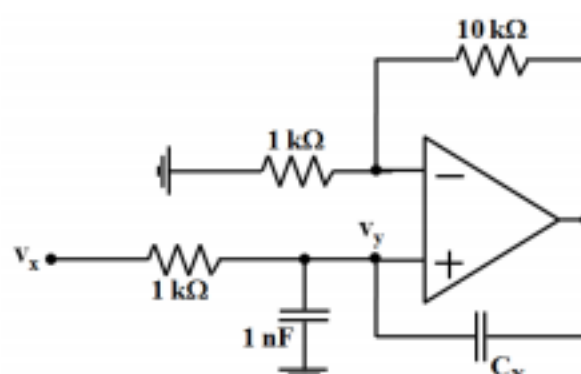
$$R(s) = \frac{1}{(s+1)^2}$$

- (A) P(s) – (3), Q(s) – (2), R(s) – (1)                      (B) P(s) – (1), Q(s) – (2), R(s) – (3)  
 (C) P(s) – (2), Q(s) – (1), R(s) – (3)                      (D) P(s) – (1), Q(s) – (3), R(s) – (2)

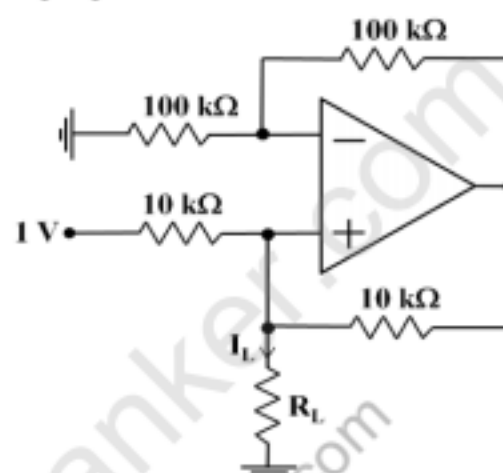
- Q.41 An ideal opamp is used to realize a difference amplifier circuit given below having a gain of 10. If  $x = 0.025$ , the CMRR of the circuit in dB is \_\_\_\_\_.



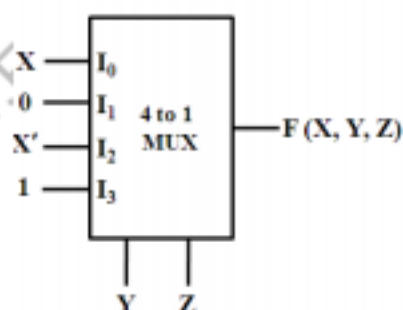
- Q.42 In the circuit given below, the opamp is ideal. The input  $v_x$  is a sinusoid. To ensure  $v_y = v_x$ , the value of  $C_N$  in **picofarad** is \_\_\_\_\_.



- Q.43 In the circuit given below, the opamp is ideal. The value of current  $I_L$  in **microampere** is \_\_\_\_\_.

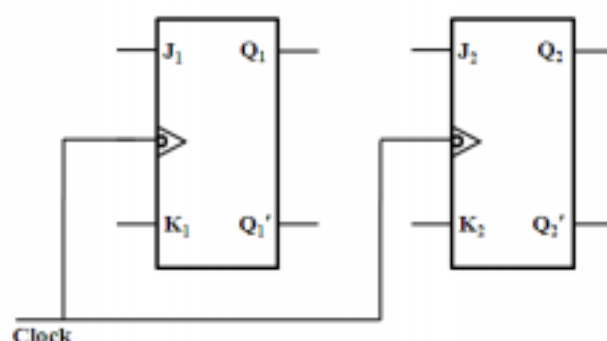


- Q.44 A 4 to 1 multiplexer to realize a Boolean function  $F(X, Y, Z)$  is shown in the figure below. The inputs  $Y$  and  $Z$  are connected to the selectors of the MUX ( $Y$  is more significant). The canonical sum-of-product expression for  $F(X, Y, Z)$  is

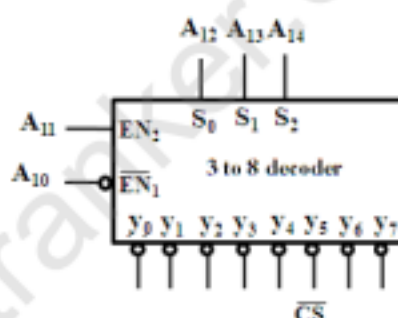


- (A)  $\sum m(2, 3, 4, 7)$  (B)  $\sum m(1, 3, 5, 7)$   
(C)  $\sum m(0, 2, 4, 6)$  (D)  $\sum m(2, 3, 5, 6)$

- Q.45 A synchronous counter using two J - K flip flops that goes through the sequence of states:  $Q_1 Q_2 = 00 \rightarrow 10 \rightarrow 01 \rightarrow 11 \rightarrow 00 \dots$  is required. To achieve this, the inputs to the flip flops are

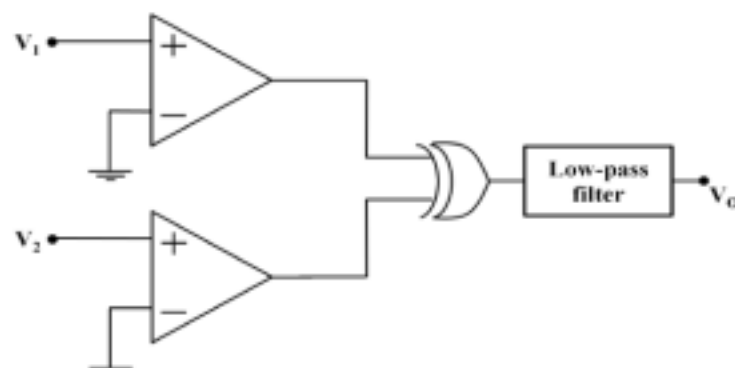


- (A)  $J_1 = Q_2, K_1 = 0 ; J_2 = Q_1', K_2 = Q_1$  (B)  $J_1 = 1, K_1 = 1 ; J_2 = Q_1, K_2 = Q_1$   
 (C)  $J_1 = Q_2, K_1 = Q_2' ; J_2 = 1, K_2 = 1$  (D)  $J_1 = Q_2', K_1 = Q_2 ; J_2 = Q_1, K_2 = Q_1'$
- Q.46 A 1 Kbyte memory module has to be interfaced with an 8-bit microprocessor that has 16 address lines. The address lines  $A_0$  to  $A_9$  of the processor are connected to the corresponding address lines of the memory module. The active low chip select  $\overline{CS}$  of the memory module is connected to the  $y_3$  output of a 3 to 8 decoder with active low outputs.  $S_0, S_1$ , and  $S_2$  are the input lines to the decoder, with  $S_2$  as the MSB. The decoder has one active low  $\overline{EN}_1$  and one active high  $EN_2$  enable lines as shown below. The address range(s) that gets mapped onto this memory module is (are)

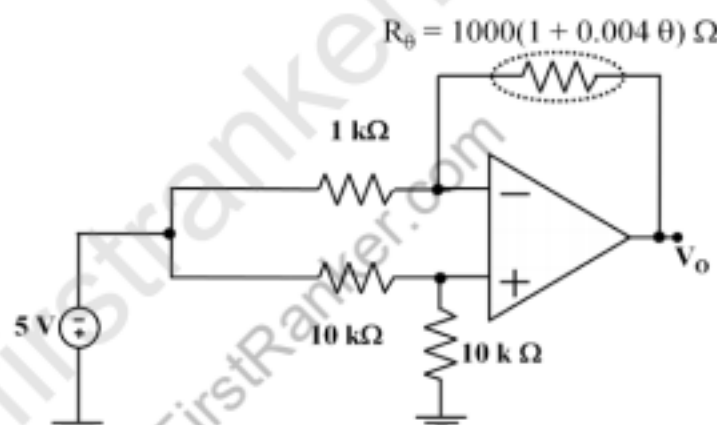


- (A)  $3000_H$  to  $33FF_H$  and  $E000_H$  to  $E3FF_H$  (B)  $1400_H$  to  $17FF_H$   
 (C)  $5300_H$  to  $53FF_H$  and  $A300_H$  to  $A3FF_H$  (D)  $5800_H$  to  $5BFF_H$  and  $D800_H$  to  $DBFF_H$
- Q.47 A coil is tested with a series type Q-meter. Resonance at a particular frequency is obtained with a capacitance of 110 pF. When the frequency is doubled, the capacitance required for resonance is 20 pF. The distributed capacitance of the coil in **pico farad** is \_\_\_\_\_.

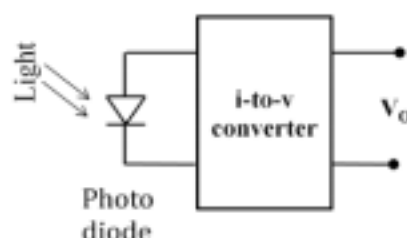
- Q.48 The comparators (output = '1', when input  $\geq 0$  and output = '0', when input  $< 0$ ), exclusive-OR gate and the unity gain low-pass filter given in the circuit are ideal. The logic output voltages of the exclusive-OR gate are 0 V and 5 V. The cutoff frequency of the low-pass filter is 0.1 Hz. For  $V_1 = 1 \sin(3000t + 36^\circ)$  V and  $V_2 = 1 \sin(3000t)$  V, the value of  $V_O$  in **volt** is \_\_\_\_\_.



- Q.49 A 200 mV full scale dual-slope  $3\frac{1}{2}$  digit DMM has a reference voltage of 100 mV and a first integration time of 100 ms. For an input of  $[100 + 10 \cos(100\pi t)]$  mV, the conversion time (without taking the auto-zero phase time into consideration) in **millisecond** is \_\_\_\_\_.
- Q.50 In the circuit below, the opamp is ideal and the sensor is an RTD whose resistance  $R_\theta = 1000(1 + 0.004\theta) \Omega$ , where  $\theta$  is temperature in  $^\circ\text{C}$ . The output sensitivity in **mV/ $^\circ\text{C}$**  is \_\_\_\_\_.

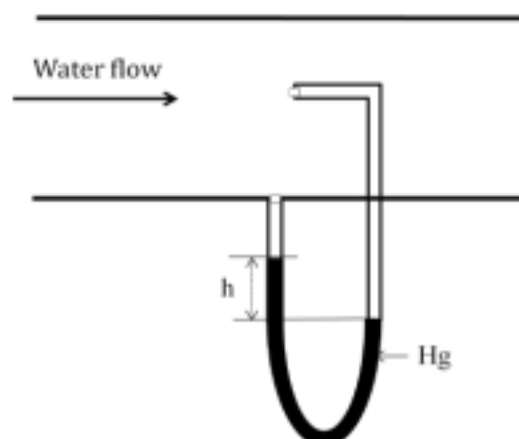


- Q.51 The photo diode in the figure below has an active sensing area of  $10 \text{ mm}^2$ , a sensitivity of  $0.5 \text{ A/W}$  and a dark current of  $1 \mu\text{A}$ . The i-to-v converter has a sensitivity of  $100 \text{ mV}/\mu\text{A}$ . For an input light intensity of  $4 \text{ W/m}^2$ , the output  $V_O$  in **volt** is \_\_\_\_\_.





- Q.52 The velocity of flow of water (density  $1000 \text{ kg/m}^3$ ) in a horizontal pipe is measured using the PITOT tube shown below. The fluid in the U-tube manometer is mercury with a density of  $13534 \text{ kg/m}^3$ . Assume  $g = 9.81 \text{ m/s}^2$ . If the height difference ( $h$ ) is measured as  $94.1 \text{ mm}$ , the velocity of flow of water in **m/s** is \_\_\_\_\_.



- Q.53 The bandgap in **eV** of a semiconductor material required to construct an LED that emits peak power at the wavelength of  $620 \text{ nm}$  is \_\_\_\_\_.  
(Planck constant  $h = 4.13567 \times 10^{-15} \text{ eV s}$  and speed of light  $c = 2.998 \times 10^8 \text{ m/s}$ ).
- Q.54 The signal  $m(t) = \frac{\sin(100 \pi t)}{100 \pi t}$  is frequency modulated (FM) with an FM modulator of frequency deviation constant of  $30 \text{ kHz/V}$ . Using Carson's rule, the approximate bandwidth of the modulated wave in **kilohertz** is \_\_\_\_\_.
- Q.55 A signal  $m(t)$  varies from  $-3.5 \text{ V}$  to  $+3.5 \text{ V}$  with an average power of  $3 \text{ W}$ . The signal is quantized using a midtread type quantizer and subsequently binary encoded. With the codeword of length 3, the signal to quantization noise ratio in **dB** is \_\_\_\_\_.

**END OF THE QUESTION PAPER**