GATE-IN-2016

EE25BTECH11002 - Achat Parth Kalpesh

Q.1-Q.5 CARRY ONE MARK EACH.

1) An apple costs Rs. 10. An onion costs Rs. 8. Select the most suitable sentence with respect to grammar and usage.

(GATE IN 2016)

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.

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.

(GATE IN 2016)

a) burning b) igniting c) clutching d) flinging

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?

(GATE IN 2016)

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.

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

(GATE IN 2016)

a) 324 b) 441 c) 97 d) 64

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 ________.

(GATE IN 2016)

a) 2.0 b) 10.0 c) 12.0 d) 22.0

Q.6 - Q.10 carry two marks each.

6) The velocity V of a vehicle along a straight line is measured in m/s and plotted as shownFig. 1 with respect to time in seconds. At the end of the 7 seconds, how much will the odometer reading increase by (in m)?

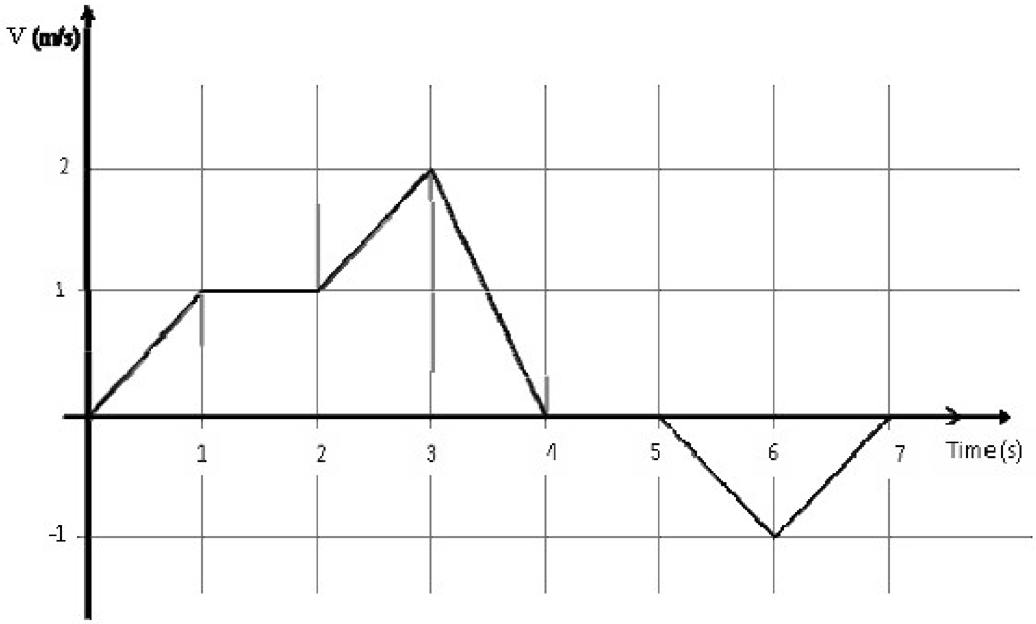

Fig. 1. *

(GATE IN 2016)

a) 0 b) 3 c) 4 d) 5

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?

(GATE IN 2016)

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.

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?

(GATE IN 2016)

a) Manu b) Sravan c) Trideep d) Pavan

9) Find the area bounded by the lines $3x + 2y = 14$, $2x - 3y = 5$ in the first quadrant.

(GATE IN 2016)

a) 14.95 b) 15.25 c) 15.70 d) 20.35

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?

(GATE IN 2016)

a) -0.030 b) -0.014 c) 0.014 d) 0.030

END OF THE QUESTION PAPER

Q. 1 - Q. 25 carry one mark each

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 ________.

(GATE IN 2016)

2) $\lim_{n\to\infty}\left(\sqrt{n^2+n}-\sqrt{n^2+1}\right)$ is ________.

(GATE IN 2016)

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 ________.

(GATE IN 2016)

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

(GATE IN 2016)

a) $(i - 2j + k)$ b) $(-i + 2j - k)$ c) $(0i + 0j + 0k)$ d) $(4i + 3j + 5k)$

5) In the neighborhood of $z = 1$, the function $f(z)$ has a power series expansion of the form

$$f(z) = 1 + (1 - z) + (1 - z)^2 + \ldots\ldots\ldots\ldots\ldots$$

Then $f(z)$ is

(GATE IN 2016)

a) $\frac{1}{z}$
b) $\frac{-1}{z-2}$
c) $\frac{z-1}{z+1}$
d) $\frac{1}{2z-1}$

6) Three currents i_1, i_2 and i_3 meet at a node as shown in the figure below.Fig. 2 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 ________.

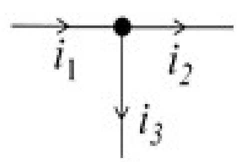

Fig. 2. *

(GATE IN 2016)

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 ________.

(GATE IN 2016)

8) A current $i(t)$ shown in the figure belowFig. 3 is passed through a 1 F capacitor that had zero initial charge. The voltage across the capacitor for $t > 2$ s in volt is ________.

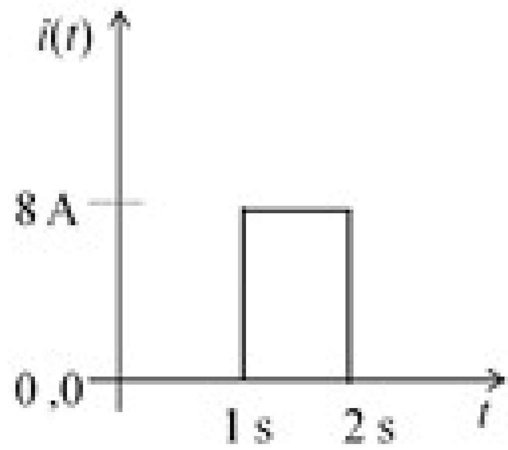

Fig. 3. *

(GATE IN 2016)

9) The signal $x[n]$ shown in the figure belowFig. 4 is convolved with itself to get $y[n]$. The value of $y[-1]$ is ________.

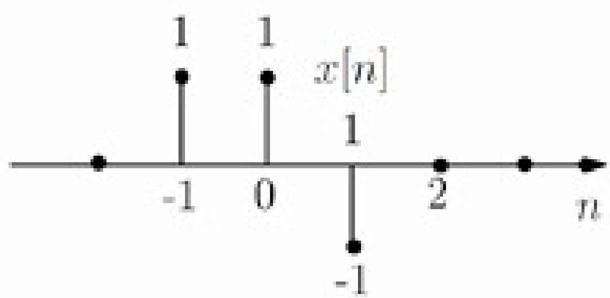

Fig. 4. *

(GATE IN 2016)

10) In the circuit shown belowFig. 5 $(v_1 + v_2) = [1\sin(2\pi 10000t) + 1\sin(2\pi 30000t)]$ V. The RMS value of the current through the resistor R will be minimum if the value of the capacitor C in microfarad is ________.

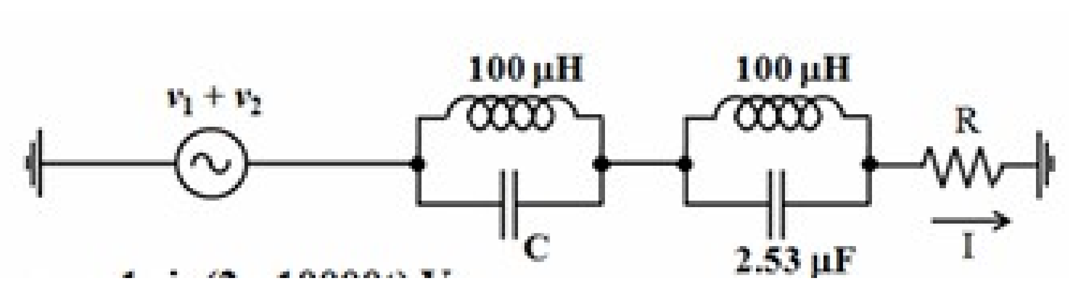

Fig. 5. *

(GATE IN 2016)

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 $t \to \infty$ is ________.

(GATE IN 2016)

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

(GATE IN 2016)

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

(GATE IN 2016)

a) 11 b) 9 c) 7 d) 5

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 ________.

(GATE IN 2016)

15) The diode D used in the circuit belowFig. 6 is ideal. The voltage drop V_{ab} across the 1 kΩ resistor in volt is ________.

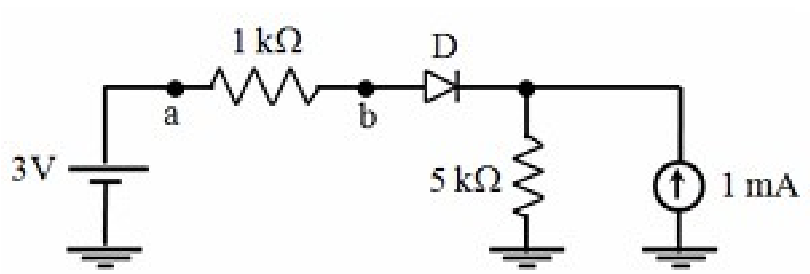

Fig. 6. *

(GATE IN 2016)

16) In the circuit given below,Fig. 7 the opamp is ideal. The output voltage V_O in volt is ________.

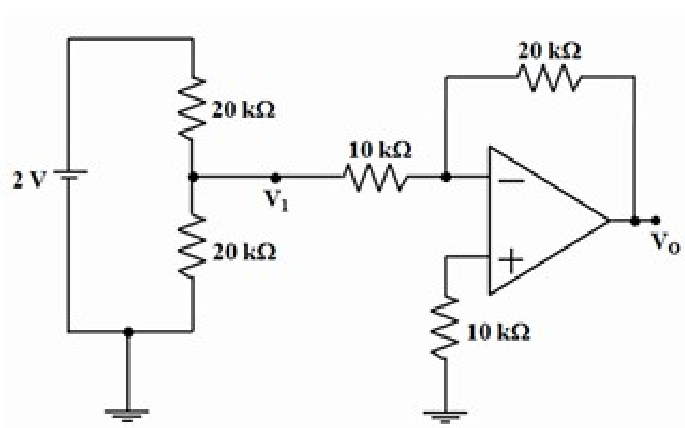

Fig. 7. *

(GATE IN 2016)

17) In the circuit given below,Fig. 8 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 ________.

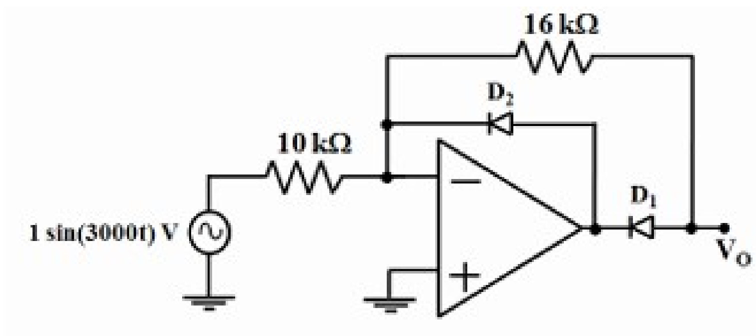

Fig. 8. *

(GATE IN 2016)

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

(GATE IN 2016)

a) $XYZ' + X'Y'Z$ b) $X'Y'Z' + XYZ$ c) $(X + Z)(Y + Z)$ d) $(X' + Z)(Y' + Z)$

19) In the digital circuit given below,Fig. 9 F is

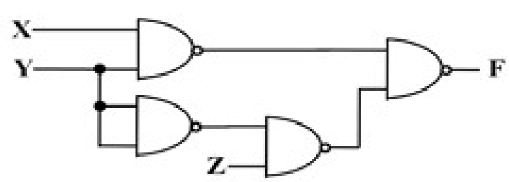

Fig. 9. *

(GATE IN 2016)

a) $XY + Y\bar{Z}$ b) $XY + \bar{Y}Z$ c) $\bar{X}Y + YZ$ d) $XZ + \bar{Y}$

20) A $3\frac{1}{2}$ digit DMM has an accuracy specification of ±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 milliampere is ________.

(GATE IN 2016)

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

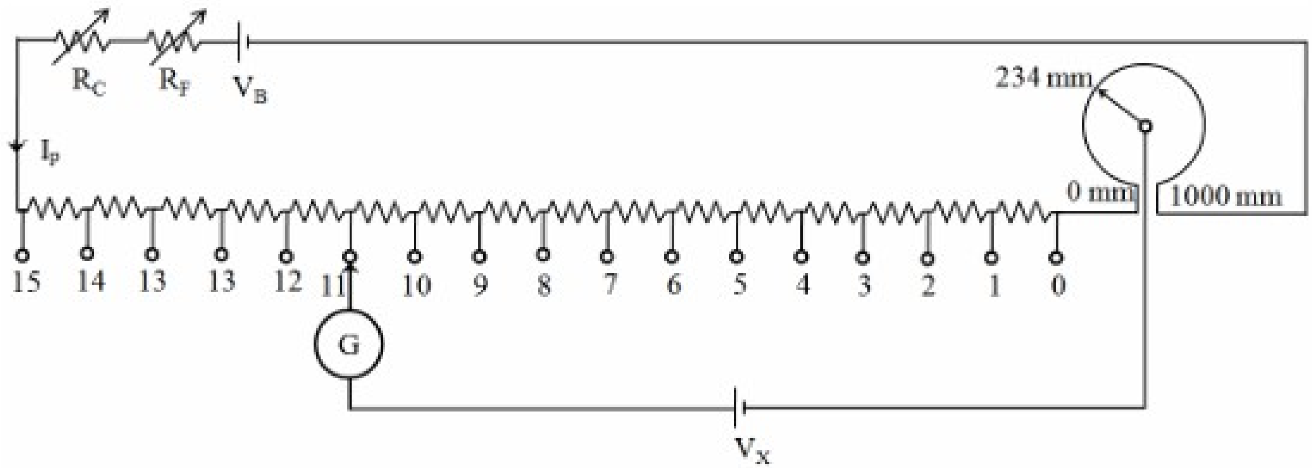

Fig. 10. *

(GATE IN 2016)

22) In the circuit given below,Fig. 11 each input terminal of the opamp draws a bias current of 10 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 ________.

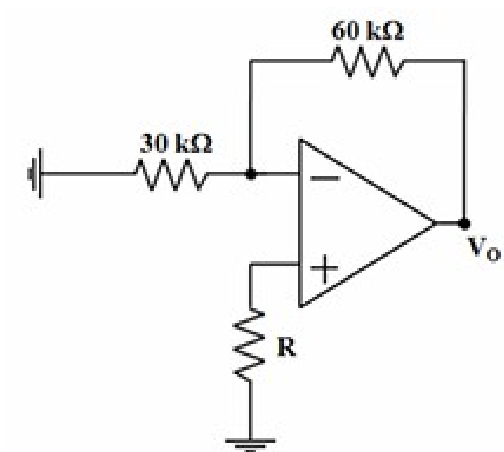

Fig. 11. *

(GATE IN 2016)

23) A peizo-electric type pressure sensor has a sensitivity of 1 mV/kPa and a bandwidth of 300 Hz to 300 kHz. For a constant (dc) pressure of 100 kPa, the steady state output of the sensor in millivolt is ________.

(GATE IN 2016)

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

(GATE IN 2016)

a) $\cos(\omega_m t)$ b) $\sin(\omega_m t)$ c) $\cos(\omega_m t) + \sin(\omega_m t)$ d) 1

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

(GATE IN 2016)

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.

26) Let $f : [-1, 1] \to \mathbb{R}$, where $f(x) = 2x^3 - x^4 - 10$. The minimum value of $f(x)$ is ________.

(GATE IN 2016)

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

(GATE IN 2016)

a) $\frac{65}{156}$ b) $\frac{67}{156}$ c) $\frac{79}{156}$ d) $\frac{89}{156}$

28) Consider the matrix

$$A = \begin{pmatrix} 2 & 1 & 1 \\ 2 & 3 & 4 \\ -1 & -1 & -2 \end{pmatrix} \tag{1}$$

whose eigenvalues are $1, -1$ and 3. Then Trace of $\left(A^3 - 3A^2\right)$ is ________.

(GATE IN 2016)

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

$$M\frac{d^2x(t)}{dt^2} + D\frac{dx(t)}{dt}(t) + Kx(t) = f(t). \tag{2}$$

$X(s)$ 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

(GATE IN 2016)

a) $\frac{10}{s^2+20s+100}$
b) $s^2 + 20s + 100$
c) $\frac{10s^2}{s^2+20s+100}$
d) $\frac{s}{s^2+20s+100}$

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

(GATE IN 2016)

31) The current I_x in the circuit given belowFig. **??** in milliampere is ________.

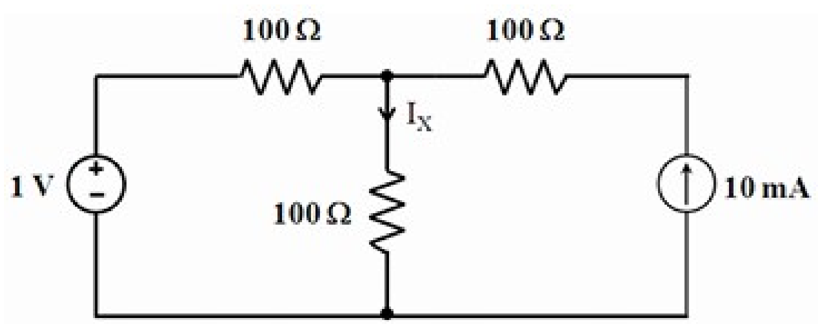

Fig. 12. *

(GATE IN 2016)

32) In the circuit shown below,Fig. 13 $V_s = 101\angle 0$ 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 ________.

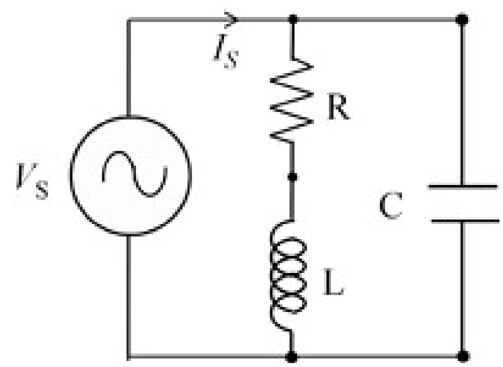

Fig. 13. *

(GATE IN 2016)

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 ________.

(GATE IN 2016)

34) In the strain gauge bridge circuit given below,Fig. 14 $R_1 = R_3 = R(1-x)$ and $R_2 = R_4 = R(1+x)$, where R is 350 Ω. The voltage sources v_s and v_n 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 ________.

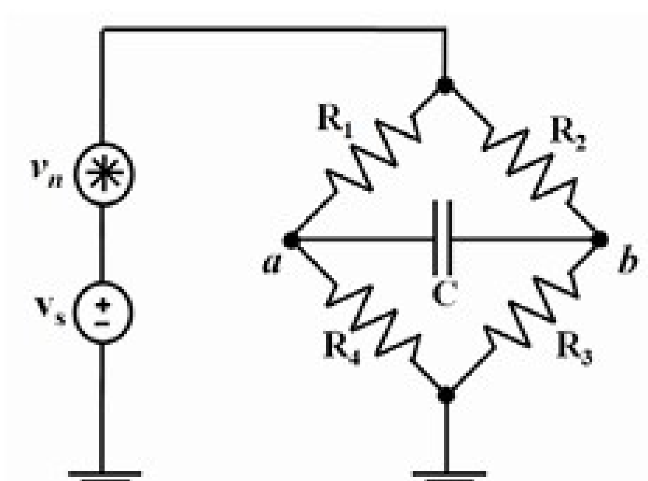

Fig. 14. *

(GATE IN 2016)

35) The voltage $v(t)$ shown belowFig. 15 is applied to the given circuit. $v(t) = 3$ V for $t < 0$ and $v(t) = 6$ V for $t > 0$. The value of current $i(t)$ at $t = 1$s, in ampere is ________.

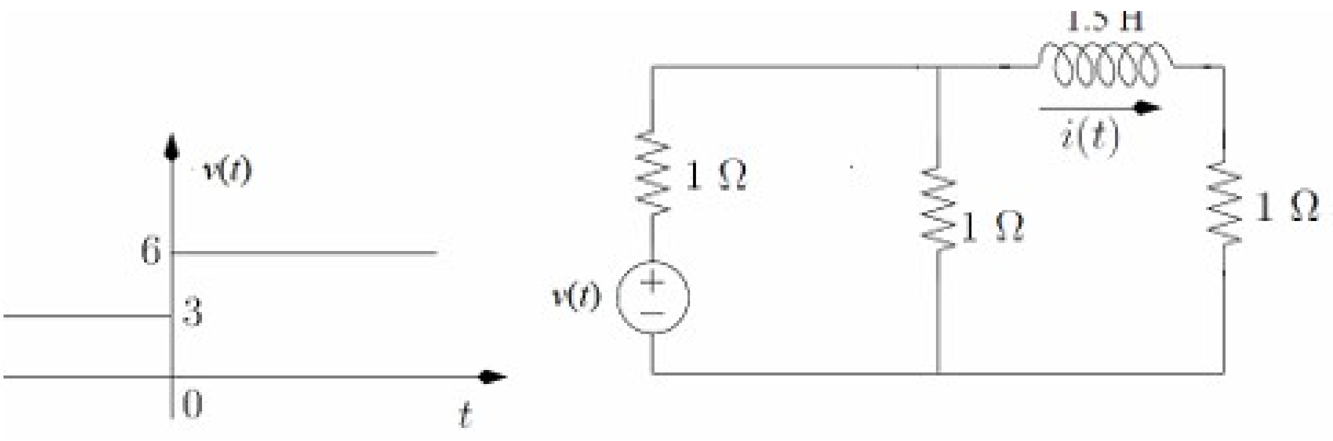

Fig. 15. *

(GATE IN 2016)

36) For the periodic signal $x(t)$ shown belowFig. 16 with period $T = 8$s, the power in the 10^{th} harmonic is

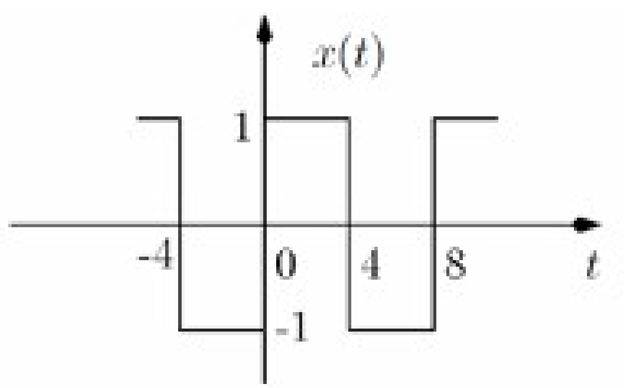

Fig. 16. *

(GATE IN 2016)

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) $\frac{1}{2}\left(\frac{4}{5\pi}\right)^2$

37) The fundamental period N_0 of the discrete-time sinusoid $x[n] = \sin\left(\frac{301}{4}\pi n\right)$ is ________.

(GATE IN 2016)

38) The transfer function G(s) of a system which has the asymptotic Bode plot shown belowFig. 17 is

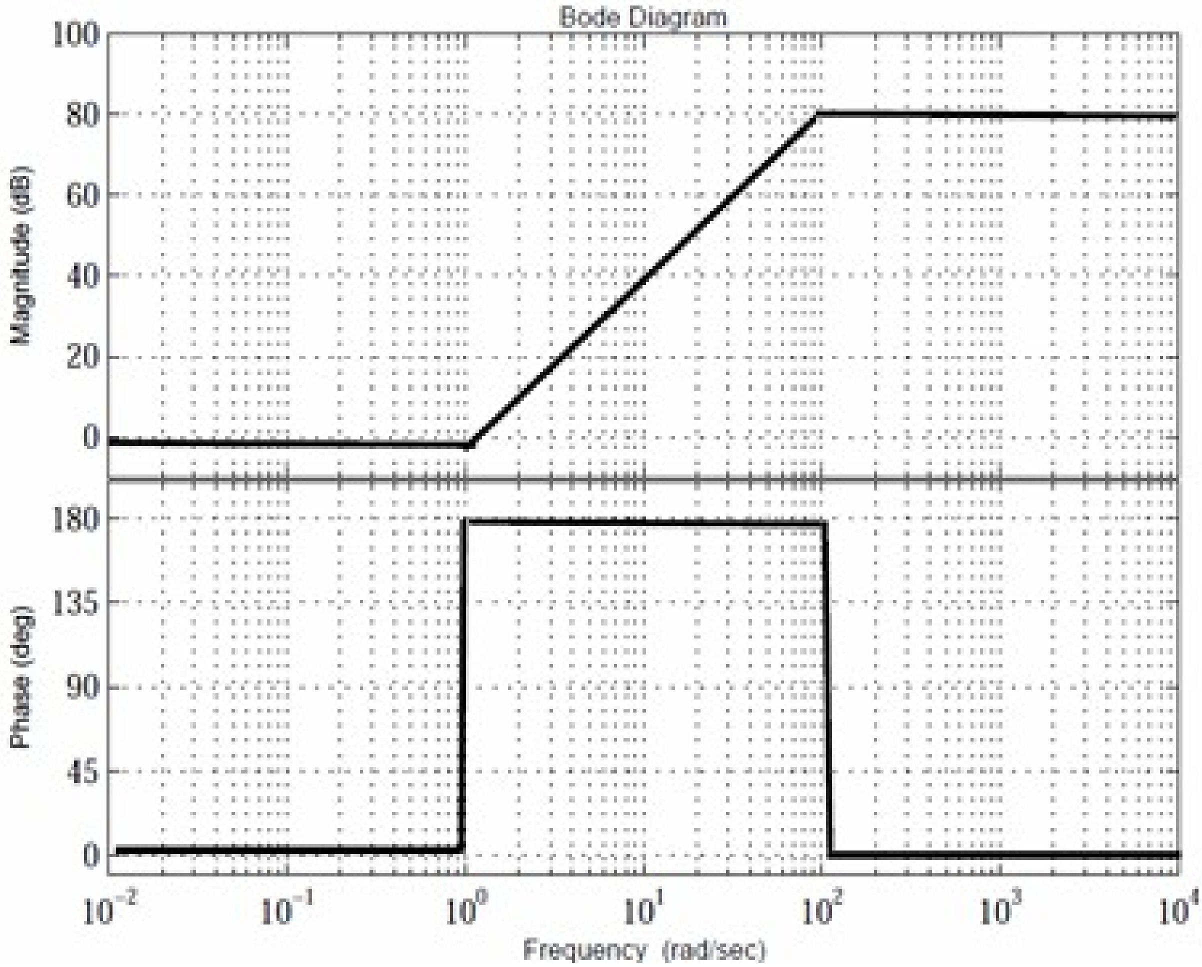

Fig. 17. *

(GATE IN 2016)

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) $10^4 \frac{(s-1)^2}{(s-100)^2}$

39) For the feedback system given below,Fig. 18 the transfer function $G(s) = \frac{1}{(s+1)^2}$. The system CANNOT be stabilized with

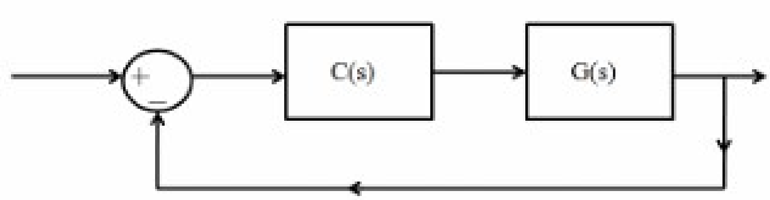

Fig. 18. *

(GATE IN 2016)

a) $C(s) = 1 + \frac{3}{s}$
b) $C(s) = 3 + \frac{7}{s}$
c) $C(s) = 3 + \frac{9}{s}$
d) $C(s) = \frac{1}{s}$

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

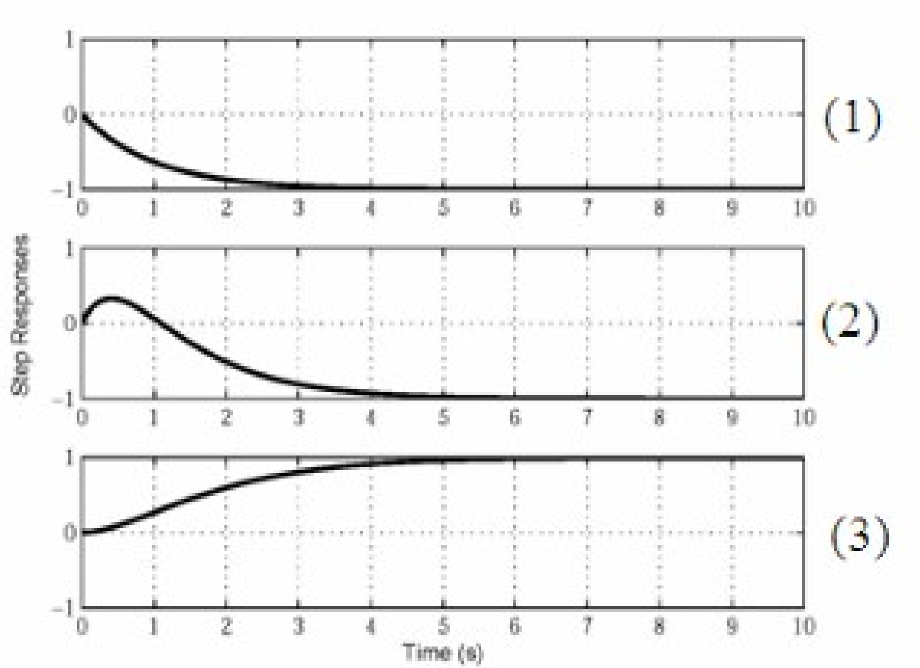

Fig. 19. *

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

TABLE I
*

(GATE IN 2016)

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)

41) An ideal opamp is used to realize a difference amplifier circuit given belowFig. 20 having a gain of 10. If $x = 0.025$, the CMRR of the circuit in dB is ________.

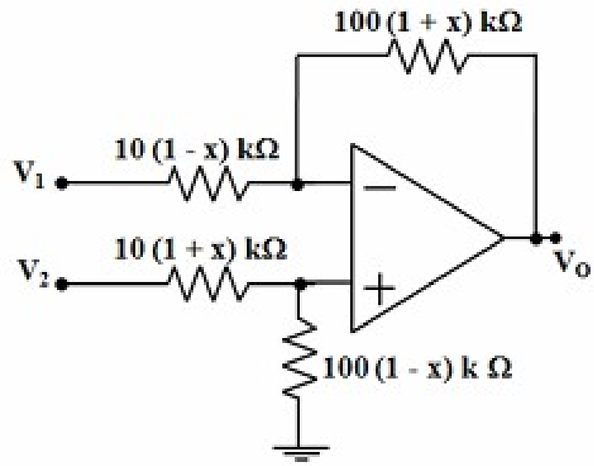

Fig. 20. *

(GATE IN 2016)

42) In the circuit given below,Fig. 21 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 ________.

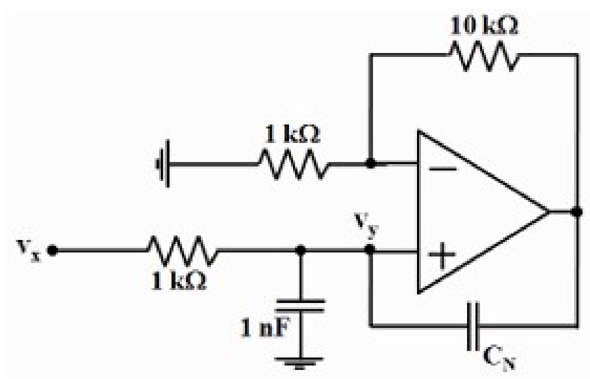

Fig. 21. *

(GATE IN 2016)

43) In the circuit given below,Fig. 22 the opamp is ideal. The value of current I_L in microampere is ________.

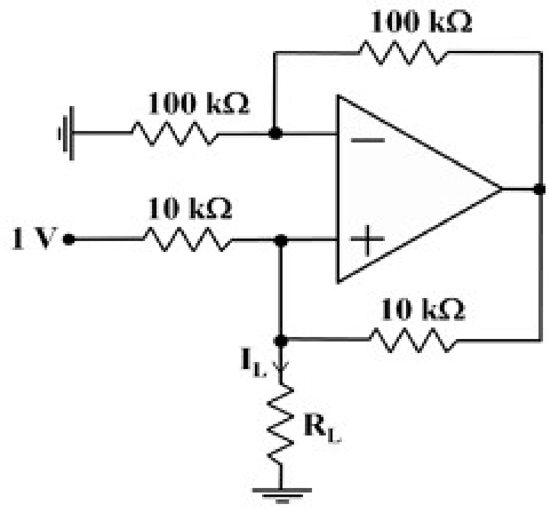

Fig. 22. *

(GATE IN 2016)

44) A 4 to 1 multiplexer to realize a Boolean function F (X, Y, Z) is shown in the figure below.Fig. 23 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

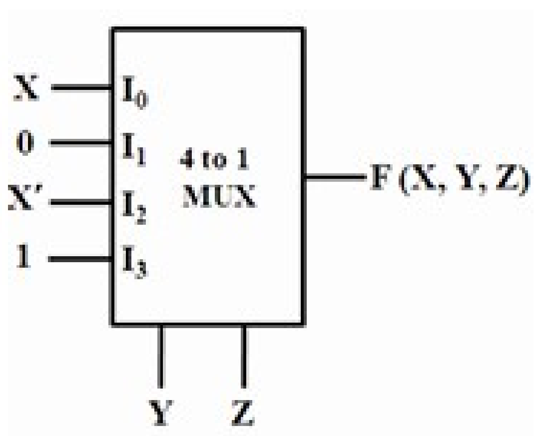

Fig. 23. *

(GATE IN 2016)

a) $\sum m(2, 3, 4, 7)$
b) $\sum m(1, 3, 5, 7)$
c) $\sum m(0, 2, 4, 6)$
d) $\sum m(2, 3, 5, 6)$

45) A synchronous counter using two J K flip flops that goes through the sequence of states: $Q_1Q_2 = 00 \rightarrow 10 \rightarrow 01 \rightarrow 11 \rightarrow 00\ldots$ is required. To achieve this, the inputs to the flip flops areFig. 24

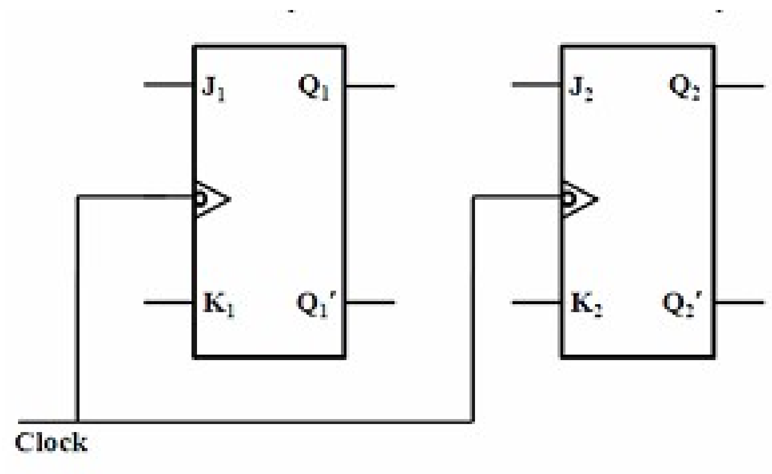

Fig. 24. *

(GATE IN 2016)

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) $J_1 = Q_2', K_1 = Q_2; J_2 = Q_1, K_2 = Q_1'$

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_5 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.Fig. 25 The address range(s) that gets mapped onto this memory module is (are)

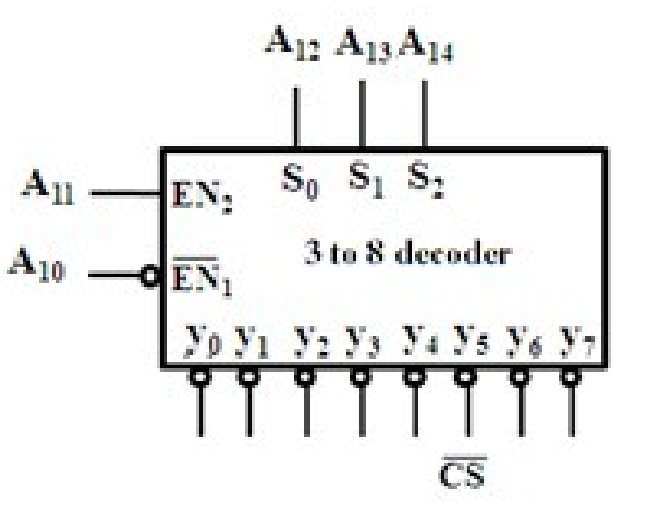

Fig. 25. *

(GATE IN 2016)

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 $DBFF_H$

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 ______.

(GATE IN 2016)

48) The comparators (output = '1', when input > 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 $V_1 = 1\sin(3000t + 36°)$ V and $V_2 = 1\sin(3000t)$ V, the value of V_O in volt is ______.Fig. 26

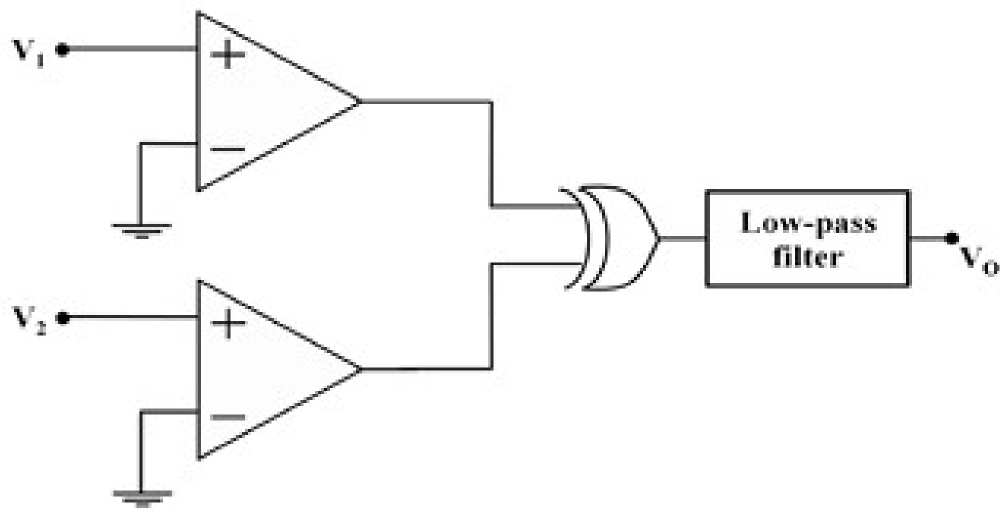

Fig. 26. *

(GATE IN 2016)

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 $(without taking the auto - zero$ in millisecond is ______.

(GATE IN 2016)

50) In the circuit below,Fig. 27 the opamp is ideal and the sensor is an RTD whose resistance $R_\theta = 1000(1 + 0.004\theta)\ \Omega$, where θ is temperature in °C. The output sensitivity in mV/°C is ______.

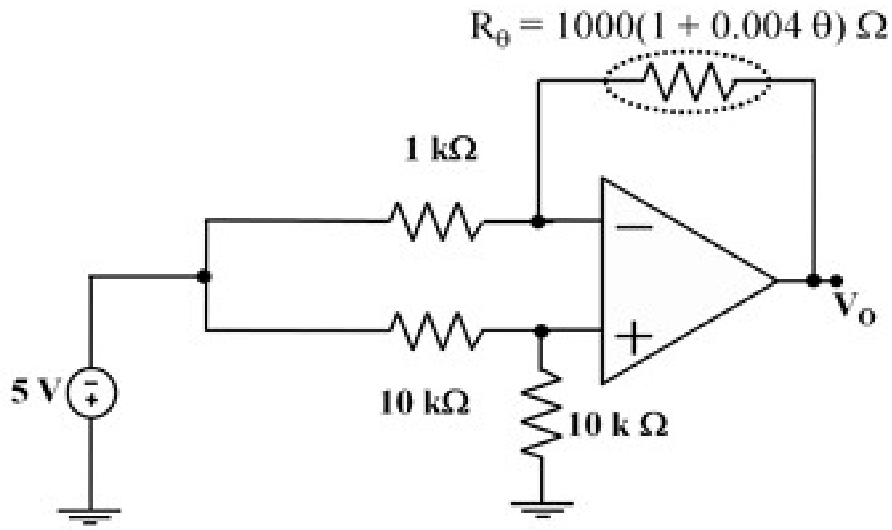

Fig. 27. *

(GATE IN 2016)

51) The photo diode in the figure belowFig. 28 has an active sensing area of 10 mm^2, a sensitivity of 0.5 A/W and a dark current of 1 μA. The i-to-v converter has a sensitivity of 100 mV/μA. For an input light intensity of 4 W/m^2, the output V_o in volt is ________.

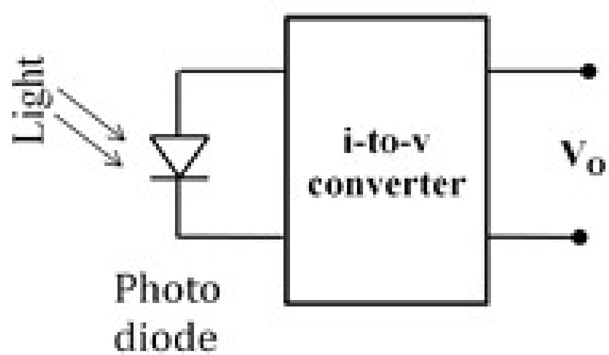

Fig. 28. *

(GATE IN 2016)

52) The velocity of flow of water $\left(\text{density } 1000 \text{ kg/m}^3\right)$ in a horizontal pipe is measured using the PITOT tube shown below.Fig. 29 The fluid in the U-tube manometer is mercury with a density of 13534 kg/m^3. Assume $g = 9.81$ m/s^2. If the height difference (h) is measured as 94.1 mm, the velocity of flow of water in m/s is ________.

(GATE IN 2016)

53) The bandgap in eV of a semiconductor material required to construct an LED that emits peak power at the wavelength of 620 nm is ________.
$\left(\text{Plank constant } h = 4.13567 \times 10^{-15} \text{ eV s and speed of light } c = 2.998 \times 10^{8} \text{ m/s}\right)$.

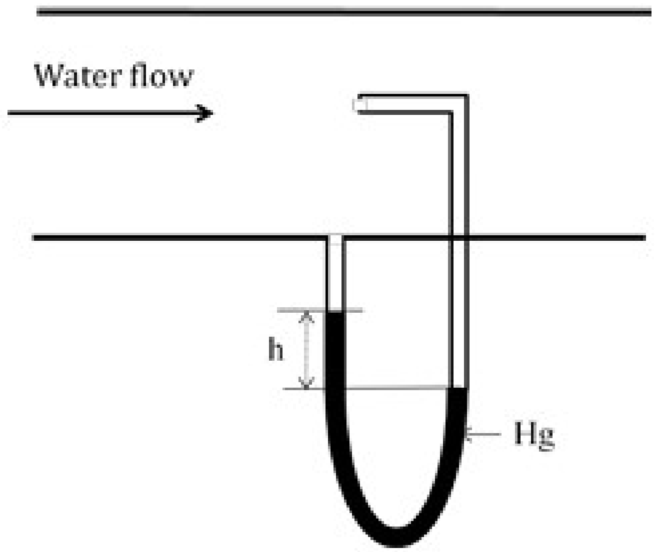

Fig. 29. *

(GATE IN 2016)

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 kHz/V. Using Carson's rule, the approximate bandwidth of the modulated wave in kilohertz is ________.

(GATE IN 2016)

55) A signal $m(t)$ varies from -3.5 V to $+3.5$ V with an average power of 3 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 ________.

(GATE IN 2016)