ELECTRONICS AND EXPERIMENTAL METHODS

NET/JRF (JUNE-2011)

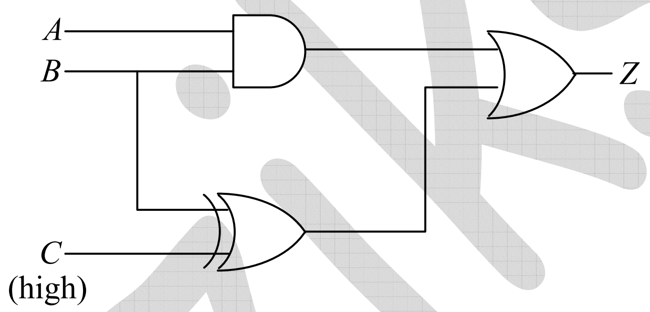
Q1. A signal of frequency $10\,kHz$ is being digitalized by an A/D converter. A possible sampling time which can be used is

(a) $100\,\mu s$ (b) $40\,\mu s$ (c) $60\,\mu s$ (d) $200\,\mu s$

Ans. : (b)

Solution: $f_S \geq 2f \Rightarrow T_S \leq \frac{1}{2f} = \frac{1}{20\times 10^3} = 50\mu s \Rightarrow T_S \leq 50\mu s$

Q2. Consider the digital circuit shown below in which the input C is always high (1).



The truth table for the circuit can be written as

A	B	Z
0	0	1
0	1	0
1	0	1
1	1	1

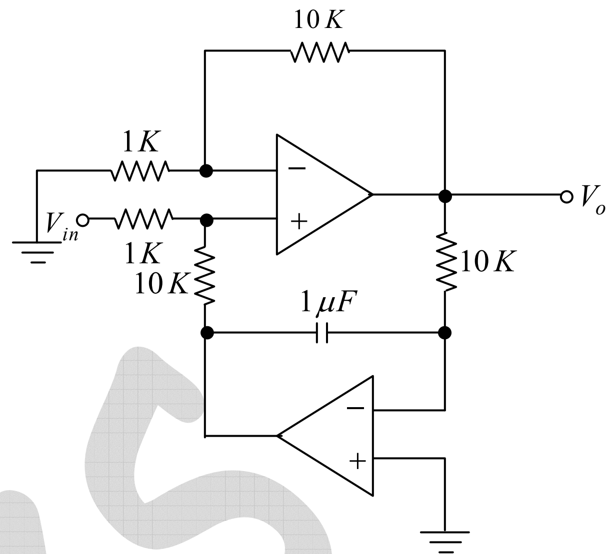
The entries in the Z column (vertically) are

(a) 1010 (b) 0100 (c) 1111 (d) 1011

Ans. : (d)

Solution: $Z = A.B + (B \oplus 1)$

Q3. A time varying signal V_{in} is fed to an op-amp circuit with output signal V_o as shown in the figure below.



The circuit implements a

(a) high pass filter with cutoff frequency 16 Hz

(b) high pass filter with cutoff frequency 100 Hz

(c) low pass filter with cutoff frequency 16 Hz

(d) low pass filter with cutoff frequency 100 Hz

Ans. : (c)

Solution: Since circuit has R and C combination, its a Low Pass filter and cutoff frequency

$$= \frac{1}{2\pi RC} \approx 16 Hz.$$

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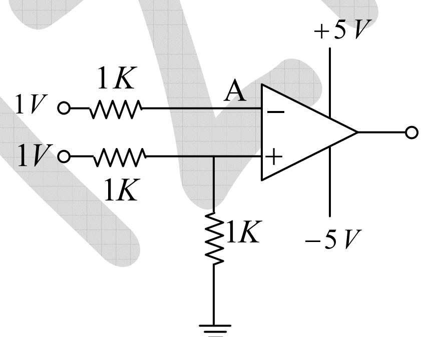
Q4. In the operational amplifier circuit below, the voltage at point A is

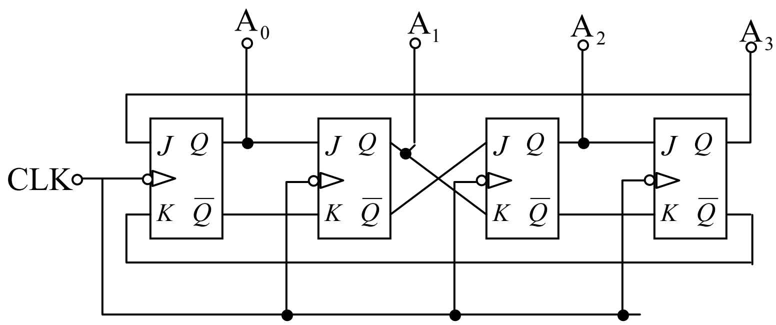


(a) 1.0V (b) 0.5V (c) 0V (d) −5.0V

Ans. : (b)

Solution: $V_A = \frac{1}{1+1} \times 1 = 0.5V$.

Q5. A counter consists of four flip-flops connected as shown in the figure:

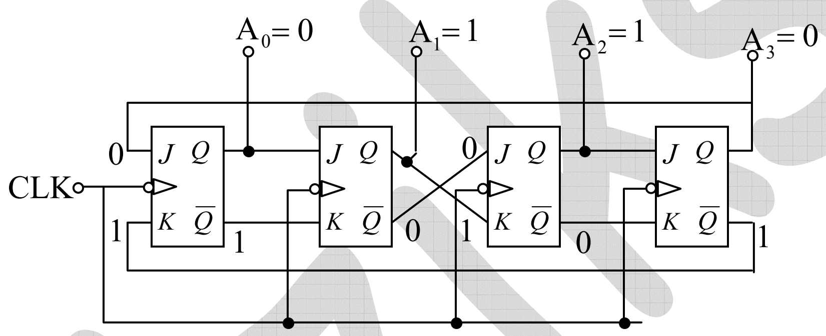


If the counter is initialized as $A_0A_1A_2A_3 = 0110$, the state after the next clock pulse is

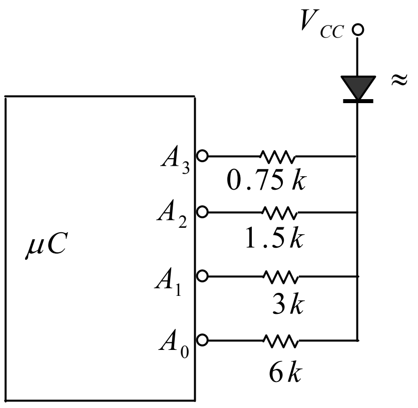
(a) 1000 (b) 0001 (c) 0011 (d) 1100

Ans. : (b)

Solution:



Q6. The pins 0, 1, 2 and 3 of part A of a microcontroller are connected with resistors to drive an LED at various intensities as shown in the figure. For $V_{CC} = 4.2$ V and a voltage drop of 1.2 V across the LED, the range (maximum current) and resolution (step size) of the drive current are, respectively,



(a) 4.0 mA and 1.0 mA

(b) 15.0 mA and 1.0 mA

(c) 7.5 mA and 0.5 mA

(d) 4.0 mA and 0.5 mA

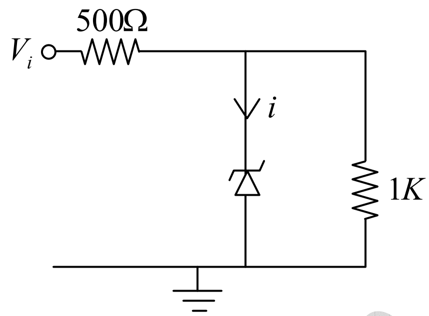
Ans. : (c)

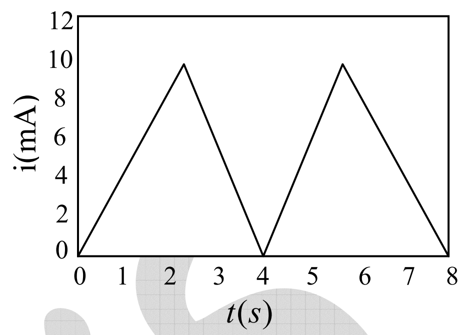
Solution: For Maximum current $\begin{matrix} A_3, A_2, A_1, A_0 \\ 0, \ 0, \ 0, \ 0 \end{matrix}$

Thus, $I_{\max} = \frac{4.2-1.2}{0.75k} + \frac{4.2-1.2}{1.5k} + \frac{4.2-1.2}{3k} + \frac{4.2-1.2}{6k} = 7.5mA$

For Step size $\begin{matrix} A_3, A_2, A_1, A_0 \\ 0, \ \ 0, \ \ 0, \ \ 1 \end{matrix}$. Thus $I_0 = \frac{4.2 - 1.2}{6k} = 0.5mA$

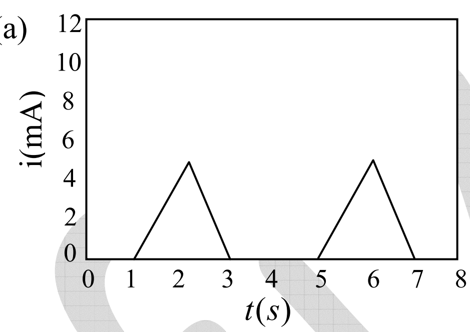
Q7. The figure below shows a voltage regulator utilizing a Zener diode of breakdown voltage 5 V and a positive triangular wave input of amplitude 10 V.



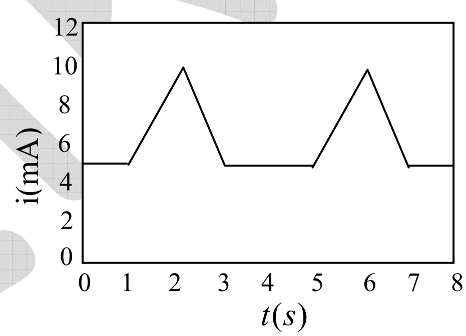


For V_i > 5V, the Zener regulates the output voltage by channeling the excess current through itself. Which of the following waveforms shows the current i passing through the Zener diode?

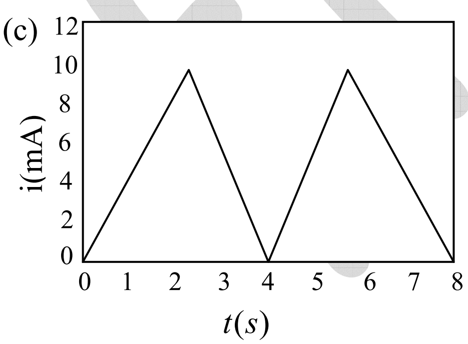
(a)



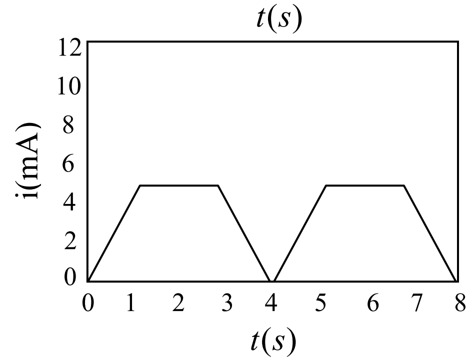
(b)



(c)



(d)



Ans. : (a)

Solution: When zener is OFF zener current is zero when zener is ON zener current will flow.

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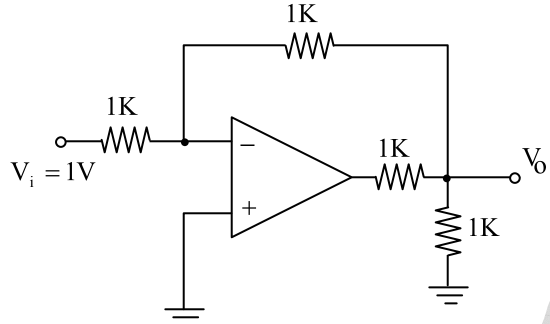
Q8. In the op-amp circuit shown in the figure below, the input voltage is 1V. The value of the output V_0 is



(a) -0.33 V (b) -0.50 V (c) -1.00 V (d) -0.25 V

Ans. : (b)

Solution: $V_0 = -\frac{R_F V_{in}}{R_1} = -\frac{1}{2}V = -0.05$ where $R_F = \frac{1\times 1}{1+1} = \frac{1}{2}K$ and $R_1 = 1K$.

Q9. An LED operates at 1.5 V and 5 mA in forward bias. Assuming an 80% external efficiency of the LED, how many photons are emitted per second?

(a) 5.0 x 10^{16} (b) 1.5 x 10^{16} (c) 0.8 x 10^{16} (d) 2.5 x 10^{16}

Ans. : (d)

Solution: $P_{in} = \eta_{ext}\frac{i}{e}hf$, number of photon $= \frac{P_{in}}{hf} = \eta_{ext}\frac{i}{e} = 0.8\times\frac{5\times10^{-3}}{1.6\times10^{-19}} = 2.5\times10^{16}$

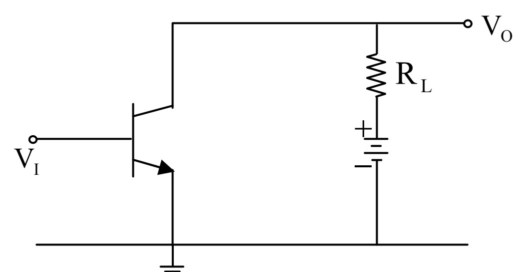
Q10. The transistor in the given circuit has h_{fe} = 35Ω and h_{ie} = 1000Ω. If the load resistance R_L = 1000Ω, the voltage and current gain are, respectively.

(a) -35 and + 35

(b) 35 and - 35

(c) 35 and – 0.97

(d) 0.98 and - 35



Ans. : (a)

Q11. The output, O, of the given circuit in cases I and II, where

Case I: A, B = 1; C, D = 0; E, F = 1 and G = 0

Case II: A, B = 0; C, D = 0: E, F = 0 and G = 1

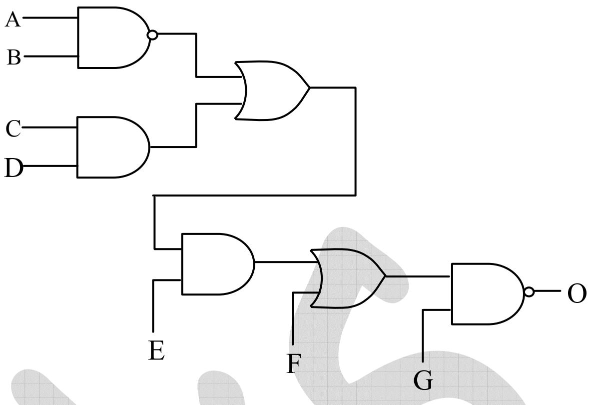
are respectively

(a) 1, 0

(b) 0, 1

(c) 0, 0

(d) 1, 1



Ans. : (d)

Solution: $O=\overline{\overline{\left(\overline{AB}+CD\right)E+F}\,G}$

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Q12. A live music broadcast consists of a radio-wave of frequency 7 MHz, amplitude-modulated by a microphone output consisting of signals with a maximum frequency of 10 kHz. The spectrum of modulated output will be zero outside the frequency band

(a) 7.00 MHz to 7.01 MHz (b) 6.99 MHz to 7.01 MHz

(c) 6.99 MHz to 7.00 MHz (d) 6.995 MHz to 7.005 MHz

Ans. : (b)

Solution: Spectrum consists of $f_c - f_m$ and $f_c + f_m$.

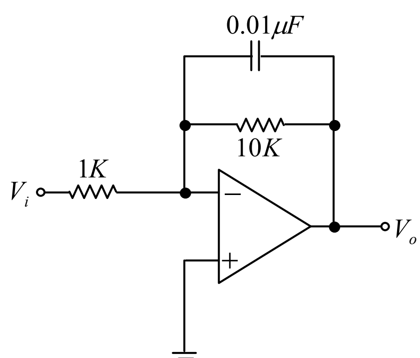
Q13. In the op-amp circuit shown in the figure, V_i is a sinusoidal input signal of frequency 10 Hz and V_0 is the output signal. The magnitude of the gain and the phase shift, respectively, close to the values

(a) $5\sqrt{2}$ and $\pi/2$

(b) $5\sqrt{2}$ and $-\pi/2$

(c) 10 and zero

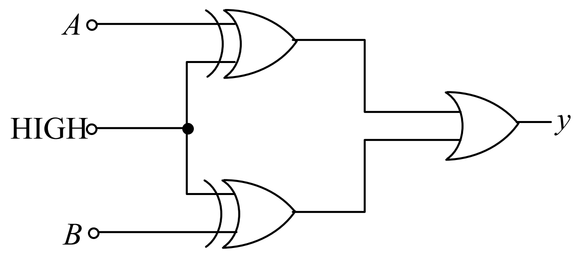
(d) 10 and π



Ans. : (d)

Solution: $\dfrac{v_0}{v_{in}} = -\dfrac{X_C R_F}{R_1\left(R_1+R_F\right)} \Rightarrow \left|\dfrac{v_0}{v_{in}}\right| \approx 10$

Q14. The logic circuit shown in the figure below Implements the Boolean expression



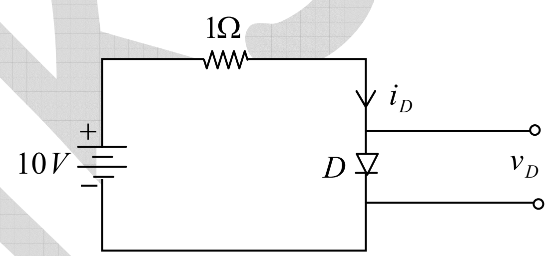
(a) $y = \overline{A \cdot B}$ (b) $y = \overline{A} \cdot \overline{B}$ (c) $y = A \cdot B$ (d) $y = A + B$

Ans. : (a)

Solution: Output of each Ex-OR gate is $\overline{A}$ and $\overline{B}$. Thus $y = \overline{A} + \vec{B} = \overline{A \cdot B}$

Q15. A diode D as shown in the circuit has an i-v relation that can be approximated by

$$i_D = \begin{cases} v_D^2 + 2v_D, & \text{for } v_D > 0 \\ 0, & \text{for } v_D \le 0 \end{cases}$$



The value of v_D in the circuit is

(a) $\left(-1+\sqrt{11}\right)V$ (b) 8 V

(c) 5 V (d) 2 V

Ans. : (d)

Solution: $-10 + \left(v_D^2 + 2v_D\right) \times 1 + v_D = 0 \Rightarrow v_D = 2V$

Q16. Band-pass and band-reject filters can be implemented by combining a low pass and a high pass filter in series and in parallel, respectively. If the cut-off frequencies of the low pass and high pass filters are ω_0^{LP} and ω_0^{HP}, respectively, the condition required to implement the band-pass and band-reject filters are, respectively,

(a) $\omega_0^{HP} < \omega_0^{LP}$ and $\omega_0^{HP} < \omega_0^{LP}$ (b) $\omega_0^{HP} < \omega_0^{LP}$ and $\omega_0^{HP} > \omega_0^{LP}$

(c) $\omega_0^{HP} > \omega_0^{LP}$ and $\omega_0^{HP} < \omega_0^{LP}$ (d) $\omega_0^{HP} > \omega_0^{LP}$ and $\omega_0^{HP} > \omega_0^{LP}$

Ans. : (b)

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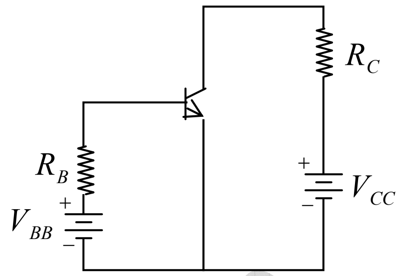
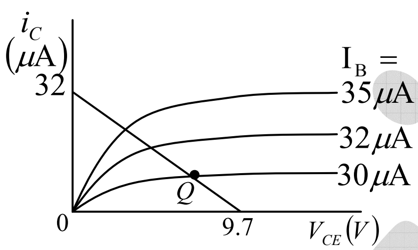
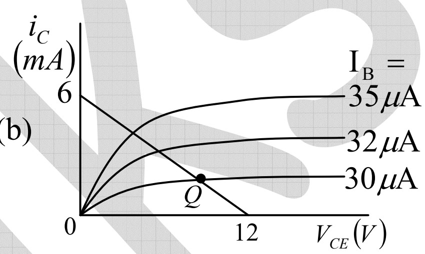
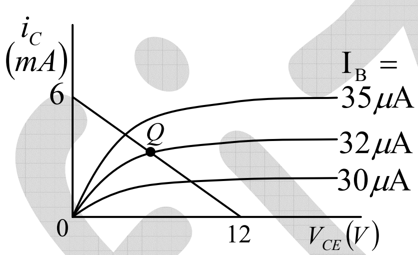
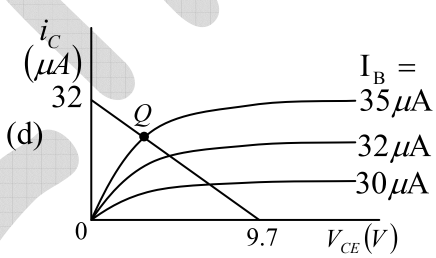
Q17. A silicon transistor with built-in voltage 0.7 V is used in the circuit shown, with $V_{BB} = 9.7V$, $R_B = 300k\Omega$, $V_{CC} = 12V$ and $R_C = 2k\Omega$. Which of the following figures correctly represents the load line and quiescent Q point?



(a)


(b)


(c)


(d)


Ans. : (b)

Solution: $I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{9.7 - 0.7}{300 \times 10^3} = 30\mu A$ and $I_{C,sat} = \frac{V_{CC}}{R_C} = \frac{12}{2 \times 10^3} = 6mA$

Q18. If the analog input to an 8-bit successive approximation ADC is increased from 1.0 V to 2.0 V, then the conversion time will

(a) remain unchanged
(b) double
(c) decrease to half its original value
(d) increase four times

Ans. : (a)

Q19. The input to a lock-in amplifier has the form $V_i(t) = V_i \sin(\omega t + \theta_i)$ where V_i, ω, θ_i are the amplitude, frequency and phase of the input signal respectively. This signal is multiplied by a reference signal of the same frequency ω, amplitude V_r and phase θ_r. If the multiplied signal is fed to a low pass filter of cut-off frequency ω, then the final output signal is

(a) $\frac{1}{2}V_iV_r \cos(\theta_i - \theta_r)$ (b) $V_iV_r\left[\cos(\theta_i - \theta_r) - \cos\left(\frac{1}{2}\omega t + \theta_i + \theta_r\right)\right]$

(c) $V_iV_r \sin(\theta_i - \theta_r)$ (d) $V_iV_r\left[\cos(\theta_i - \theta_r) + \cos\left(\frac{1}{2}\omega t + \theta_i + \theta_r\right)\right]$

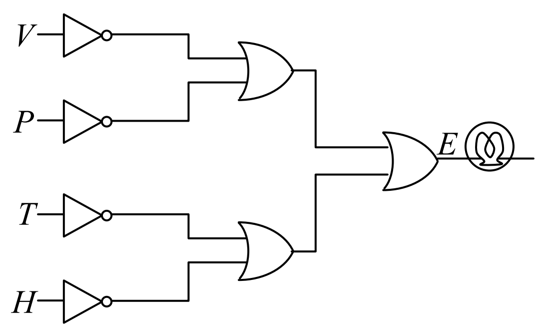
Ans. : (a)

Solution: $V = V_r \sin(\omega t + \theta_r) \times V_i \sin(\omega t + \theta_i) = \frac{V_iV_r}{2}\left[\cos(\theta_i - \theta_r) - \cos(2\omega t + \theta_i + \theta_r)\right]$

Output of low pass filter$=\frac{V_iV_r}{2}\cos(\theta_i - \theta_r)$

Q20. Four digital outputs V, P, T and H monitor the speed v, tyre pressure p, temperature t and relative humidity h of a car. These outputs switch from 0 to 1 when the values of the parameters exceed 85 km/hr, 2 bar, $40^0 C$ and 50%, respectively. A logic circuit that is used to switch ON a lamp at the output E is shown below.

Which of the following condition will not switch the lamp ON?



(a) $v < 85km/hr, p < 2bar, t > 40^0 C, h > 50\%$

(b) $v < 85km/hr, p < 2bar, t > 40^0 C, h < 50\%$

(c) $v > 85km/hr, p < 2bar, t > 40^0 C, h < 50\%$

(d) $v > 85km/hr, \ p > 2 \ bar, \ t > 40^0 C, \ h > 50\%$

Ans. : (d)

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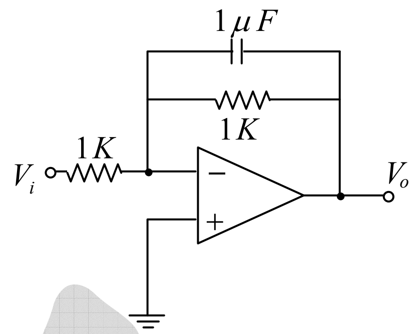
Q21. Consider the op-amp circuit shown in the figure.

If the input is a sinusoidal wave $V_i = 5\sin(1000t)$, then the amplitude of the output V_0 is



(a) $\frac{5}{2}$ (b) 5

(c) $\frac{5\sqrt{2}}{2}$ (d) $5\sqrt{2}$

Ans. : (c)

Solution: $\frac{v_o}{v_{in}} = -\frac{X_F}{R_1}$, $X_F = \frac{R_F X_C}{R_F + X_C} = \frac{10^3}{(1+j)}$ where $R_F = 1\times 10^3\,\Omega$, $X_C = \frac{1}{j\times 10^3 \times 10^{-6}}$

$$\left|\frac{v_o}{v_{in}}\right| = \frac{10^3}{\sqrt{2}} \times \frac{1}{10^3} = \frac{1}{\sqrt{2}} \Rightarrow v_o = \frac{5}{\sqrt{2}}\sin\omega t = \frac{5\sqrt{2}}{2}\sin\omega t$$

Q22. If one of the inputs of a J-K flip flop is high and the other is low, then the outputs Q and $\overline{Q}$

(a) oscillate between low and high in race around condition

(b) toggle and the circuit acts like a T flip flop

(c) are opposite to the inputs

(d) follow the inputs and the circuit acts like an $R-S$ flip flop

Ans. : (d)

Q23. A sample of Si has electron and hole mobilities of 0.13 and $0.05\,\text{m}^2/\text{V-s}$ respectively at 300 K. It is doped with P and Al with doping densities of $1.5\times 10^{21}/\text{m}^3$ and $2.5\times 10^{21}/\text{m}^3$ respectively. The conductivity of the doped Si sample at 300 K is

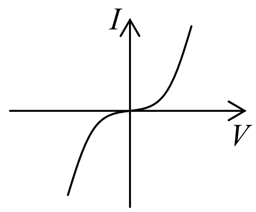
(a) $8\ \Omega^{-1}m^{-1}$ (b) $32\ \Omega^{-1}m^{-1}$ (c) $20.8\ \Omega^{-1}m^{-1}$ (d) $83.2\ \Omega^{-1}m^{-1}$

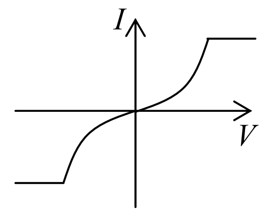
Ans. : (a)

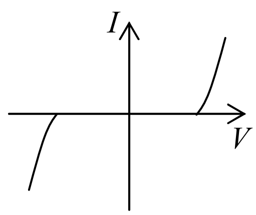
Solution: Resulting doped crystal is *p*-type and $p_p = (2.5-1.5)\times 10^{21}/m^3 = 1\times 10^{21}/m^3$

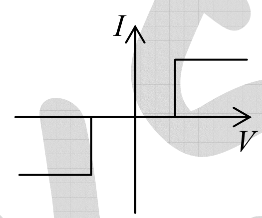
$$\sigma = e(n_p\mu_n + p_p\mu_p) \approx ep_p\mu_p = 1.6\times 10^{-19} \times 1\times 10^{21} \times 0.05 = 8\ \Omega^{-1}m^{-1}$$

Q24. Two identical Zener diodes are placed back to back in series and are connected to a variable DC power supply. The best representation of the *I-V* characteristics of the circuit is

(a)


(b)


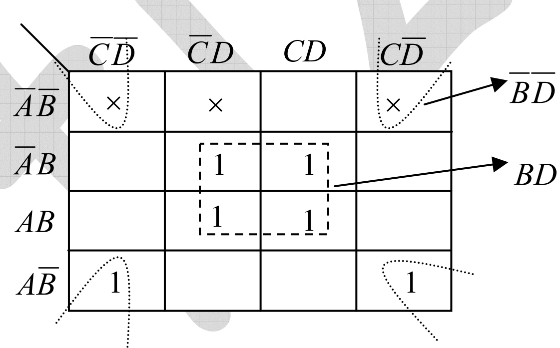
(c)


(d)


Ans. : (d)

Q25. A 4-variable switching function is given by $f = \sum(5, 7, 8, 10, 13, 15) + d(0, 1, 2)$, where d is the do-not-care-condition. The minimized form of f in sum of products (SOP) form is

(a) $\bar{A}\bar{C} + \bar{B}\bar{D}$ (b) $A\bar{B} + C\bar{D}$ (c) $AD + BC$ (d) $\bar{B}\bar{D} + BD$

Ans. : (d)


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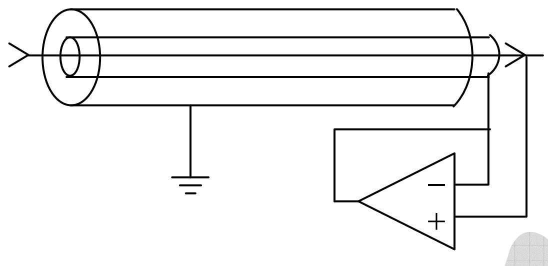
Q26. The inner shield of a triaxial conductor is driven by an (ideal) op-amp follower circuit as shown. The effective capacitance between the signal-carrying conductor and ground is



(a) unaffected (b) doubled (c) halved (d) made zero

Ans. : (a)

Q27. An op-amp based voltage follower

(a) is useful for converting a low impedance source into a high impedance source.

(b) is useful for converting a high impedance source into a low impedance source.

(c) has infinitely high closed loop output impedance

(d) has infinitely high closed loop gain

Ans. : (b)

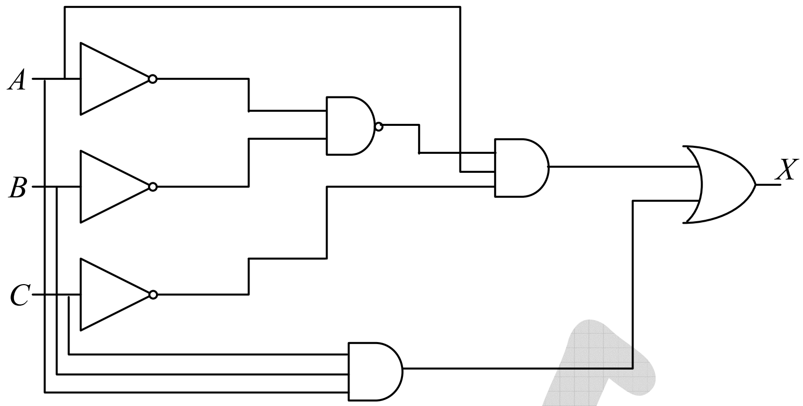
Q28. An RC network produces a phase-shift of 30°. How many such RC networks should be cascaded together and connected to a Common Emitter amplifier so that the final circuit behaves as an oscillator?

(a) 6 (b) 12 (c) 9 (d) 3

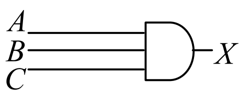
Ans. : (a)

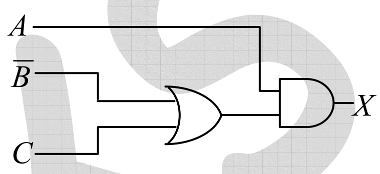
Solution: Total phase shift must be 0 or 360^0. Common Emitter amplifier has phase change of 180^0 so we need 6 RC network for next 180^0 phase shift.

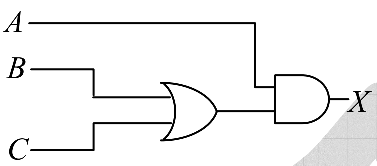
Q29. For the logic circuit shown in the below

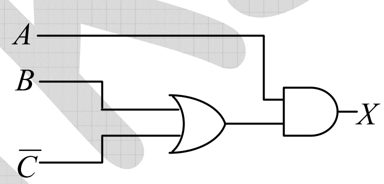


A simplified equivalent circuit is

(a)


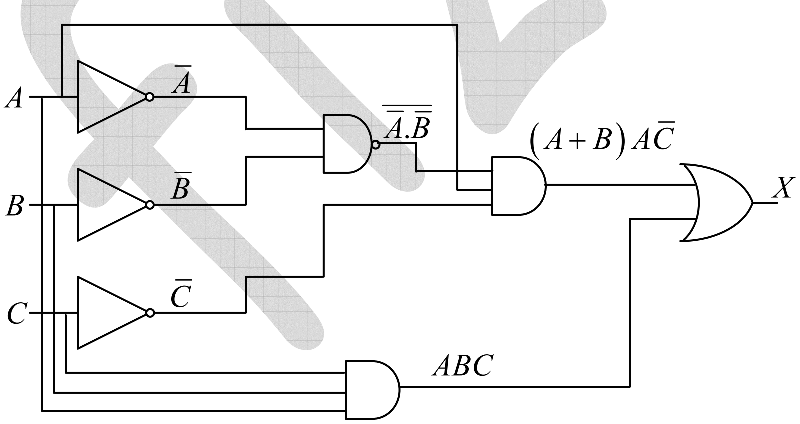
(b)


(c)


(d)


Ans. : (d)

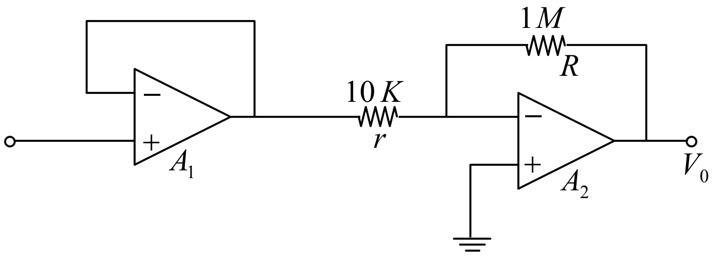
Solution:



$$X = (A+B)A\overline{C} + ABC = A\overline{C} + AB\overline{C} + ABC = A\overline{C} + AB = A(B+\overline{C})$$

NET/JRF (DEC-2014)

Q30. Consider the amplifier circuit comprising of the two op-amps A_1 and A_2 as shown in the figure.



If the input ac signal source has an impedance of $50k\Omega$, which of the following statements is true?

(a) A_1 is required in the circuit because the source impedance is much greater than r

(b) A_1 is required in the circuit because the source impedance is much less than R

(c) A_1 can be eliminated from the circuit without affecting the overall gain

(d) A_1 is required in the circuit if the output has to follow the phase of the input signal

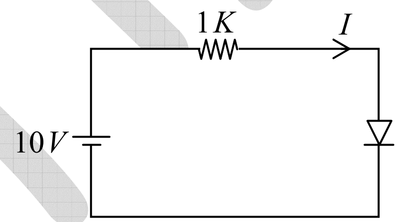
Ans. : (a)

Solution: A_1 is required in the circuit because the source impedance is much greater than r

Q31. The $I-V$ characteristics of the diode in the circuit below is given by

$$I = \begin{cases} (V-0.7)/500 & \text{for} \quad V \geq 0.7 \\ 0 & \text{for} \quad V < 0.7 \end{cases}$$

where V is measured in volts and I is measured in amperes.



The current I in the circuit is

(a) 10.0 mA (b) 9.3 mA (c) 6.2 mA (d) 6.7 mA

Ans. : (c)

Solution: Applying K.V.L. $-10+1000\times I+V=0 \Rightarrow -10+1000\times(V-0.7)/500+V=0$

$\Rightarrow -10+2(V-0.7)+V=0 \Rightarrow 3V=11.4 \Rightarrow V=3.8\ Volts$

Thus $I=(V-0.7)/500=(3.8-0.7)/500=3.1/500=6.2\ mA$

Q32. In a measurement of the viscous drag force experienced by spherical particles in a liquid, the force is found to be proportional to $V^{1/3}$ where V is the measured volume of each particle. If V is measured to be $30\,mm^3$, with an uncertainty of $2.7\,mm^3$, the resulting relative percentage uncertainty in the measured force is

(a) 2.08 (b) 0.09 (c) 6 (d) 3

Ans. : (b)

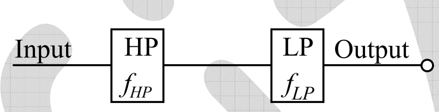
Solution: The relative percentage uncertainty in the measure force is $\sigma_F^2 = \left(\frac{\partial F}{\partial V}\right)^2 \sigma_V^2$

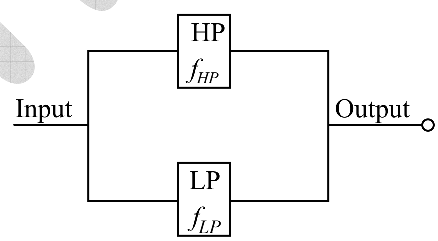
$\Rightarrow \sigma_F = \left(\frac{\partial F}{\partial V}\right)\sigma_V$ where σ_V is the uncertainty in the measurement of volume.

$$\because F = V^{1/3} \Rightarrow \frac{\partial F}{\partial V} = \frac{1}{3}V^{-2/3}$$

$$\therefore \sigma_F = \frac{1}{3V^{2/3}} \times \sigma_V = \frac{1}{3(30)^{2/3}} \times 2.7 = \frac{1}{3 \times (900)^{1/3}} \times 2.7 = \frac{1}{3 \times 9.7} \times 2.7 \Rightarrow \sigma_F = 0.09$$

Q33. Consider a Low Pass (LP) and a High Pass (HP) filter with cut-off frequencies f_{LP} and f_{HP}, respectively, connected in series or in parallel configurations as shown in the Figures A and B below.

(A) 

(B) 

Which of the following statements is correct?

(a) For $f_{HP} < f_{LP}$, A acts as a Band Pass filter and B acts as a band Reject filter

(b) For $f_{HP} > f_{LP}$, A stops the signal from passing through and B passes the signal without filtering

(c) For $f_{HP} < f_{LP}$, A acts as a Band Pass filter and B passes the signal without filtering

(d) For $f_{HP} > f_{LP}$, A passes the signal without filtering and B acts as a Band Reject filter

Ans. : (c)

Q34. The power density of sunlight incident on a solar cell is $100\,mW/cm^2$. Its short circuit current density is $30\,mA/cm^2$ and the open circuit voltage is $0.7\,V$. If the fill factor of the solar cell decreases from 0.8 to 0.5 then the percentage efficiency will decrease from

(a) 42.0 to 26.2 (b) 24.0 to 16.8 (c) 21.0 to 10.5 (d) 16.8 to 10.5

Ans. : (d)

Solution: The efficiency of a solar cell is determined as the fraction of incident power which is converted to electricity and is defined as

$$\eta = \frac{V_{oc} I_{sc} FF}{P_{in}} \text{ and } P_{\max} = V_{oc} I_{sc} FF$$

where V_{oc} is the open circuit voltage, I_{sc} is the short circuit current density , FF is the Fill factor, P_{in} is the input power and η is the efficiency of the solar cell.

Given $P_{in} = 100\, mW/cm^2$, $I_{sc} = 30\, mA/cm^2$, $V_{oc} = 0.7V$

Let η_1 is the efficiency of solar cell when $FF = 0.8$

$$\therefore \eta_1 = \frac{(0.7V)\times(30\times10^{-3} A/cm^2)\times 0.8}{100\times10^{-3} W/cm^2} = \frac{16.8}{100} \Rightarrow \eta_1 = 0.168$$

Let η_2 is the efficiency of solar cell when $FF = 0.5$

$$\therefore \eta_2 = \frac{(0.7V)\times(30\times10^{-3} A/cm^2)\times 0.5}{100\times10^{-3} W/cm^2} = \frac{10.5}{100} \Rightarrow \eta_2 = 0.105$$

Thus efficiency decreases from $\eta_1 = 16.8\%$ to $\eta_2 = 10.5\%$

NET/JRF (JUNE-2015)

Q35. The concentration of electrons, n and holes p, for an intrinsic semiconductor at a temperature T can be expressed as $n = p = AT^{\frac{3}{2}} \exp\left(-\frac{E_g}{2k_BT}\right)$, where E_g is the band gap and A is a constant. If the mobility of both types of carrier is proportional to $T^{\frac{-3}{2}}$, then the log of the conductivity is a linear function of T^{-1}, with slope

(a) $\frac{E_g}{(2k_B)}$ (b) $\frac{E_g}{k_B}$ (c) $\frac{-E_g}{(2k_B)}$ (d) $\frac{-E_g}{k_B}$

Ans. (c)

Solution: $\sigma_i = n_i e(\mu_e + \mu_p) \propto T^{\frac{3}{2}} \exp\left(\frac{-E_g}{2k_BT}\right) \times T^{\frac{-3}{2}} \Rightarrow \sigma_i = C \exp\left(\frac{-E_g}{2k_BT}\right)$

$$\ln(\sigma_i) = \frac{E_g}{2k_BT} + \ln C \Rightarrow \text{slope is } \frac{-E_g}{2k_B}$$

Q36. The viscosity η of a liquid is given by Poiseuille's formula $\eta = \frac{\pi P a^4}{8lV}$. Assume that l and V can be measured very accurately, but the pressure P has an rms error of 1% and the radius a has an independent rms error of 3%. The rms error of the viscosity is closest to

(a) 2% (b) 4% (c) 12% (d) 13%

Ans. (c)

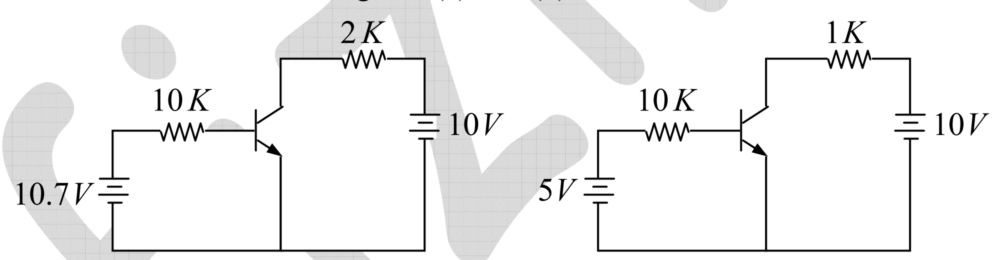
Solution: $\eta = kPa^4$

$$\sigma_n^2 = \left(\frac{\partial \eta}{\partial P}\right)\sigma_p^2 + \left(\frac{\partial \eta}{\partial a}\right)^2 \sigma_a^2 = \left(a^4\right)^2 \sigma_p^2 + \left(4Pa^3\right)^2 \sigma_a^2$$

$$\Rightarrow \left(\frac{\sigma_n}{n}\times 100\right)^2 = \left(\frac{\sigma_p}{p}\times 100\right)^2 + 16\left(\frac{\sigma_a}{a}\times 100\right)^2 = (1)^2 + 16(3)^2 = 1 + 144 = 145$$

$$\Rightarrow \left(\frac{\sigma_n}{n}\times 100\right) = 12\%$$

Q37. Consider the circuits shown in figures (a) and (b) below



(a) (b)

If the transistors in Figures (a) and (b) have current gain $\left(\beta_{dc}\right)$ of 100 and 10 respectively, then they operate in the

(a) active region and saturation region respectively

(b) saturation region and active region respectively

(c) saturation region in both cases

(d) active region in both cases

Ans. (b)

Solution: In both case input section is F.B.

For figure (a) $I_B = \frac{10.7 - 0.7}{10} = 1\ mA \Rightarrow I_C = BI_B = 100\ mA$

Thus $V_{CB} = V_C - V_B = (10 - 2\times 100) - 0.7 = -ve$

$\Rightarrow$ output section is F.B.

since both section are F.B. so it is in saturation region.

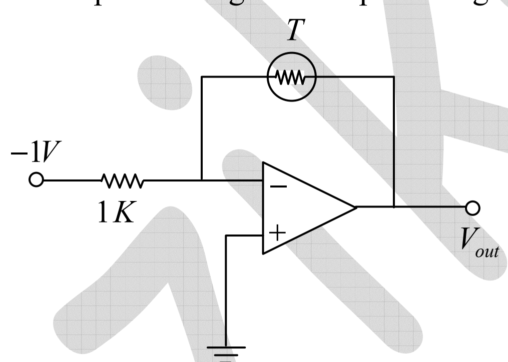
For Figure (b) $I_B = \frac{5-0.7}{10} = 0.43\ mA \Rightarrow I_C = BI_B = 4.3\ mA$

Thus $V_{CB} = V_C - V_B = (10 - 4.3) - 0.7) = +ve$

$\Rightarrow$ out put section is R.B.

Thus it is in active region

Q38. In the circuit given below, the thermistor has a resistance $3\ k\Omega$ at $25^0 C$. Its resistance decreases by 150Ω per ^0C upon heating. The output voltage of the circuit at $30^0 C$ is



(a) $-3.75\ V$ (b) $-2.25\ V$ (c) $2.25\ V$ (d) $3.75\ V$

Ans. (c)

Solution: At $30^0 C$, Resistance $= 3000 - 150\times 5 = 2250\ \Omega$

$$\Rightarrow V_0 = -\frac{R_F}{R_1} v_i = \frac{-2250}{1000} \times -1 \Rightarrow V_0 = 2.25 \text{ volts}$$

NET/JRF (DEC-2015)

Q39. If the reverse bias voltage of a silicon varactor is increased by a factor of 2, the corresponding transition capacitance

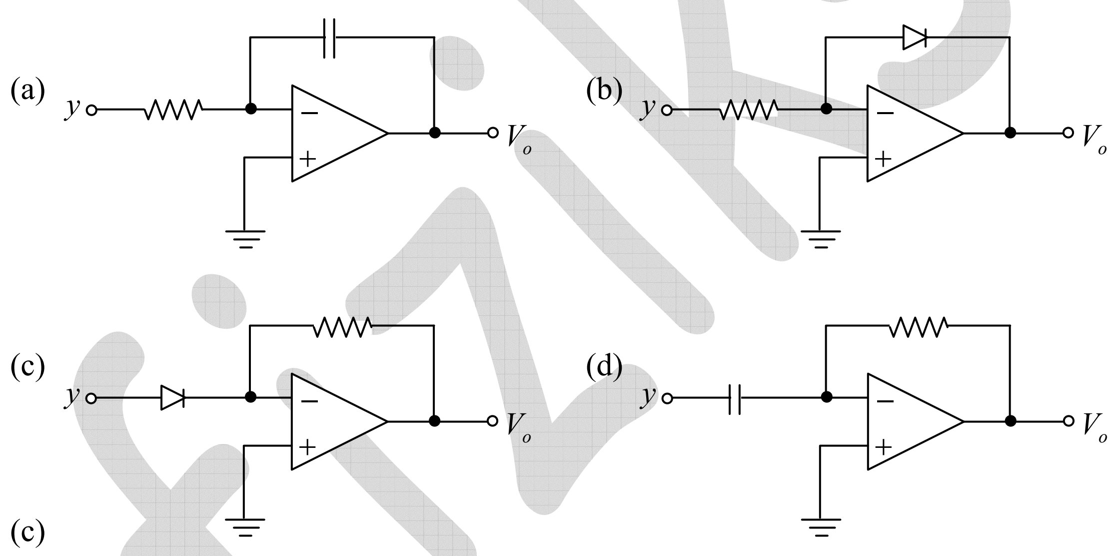
(a) increases by a factor of $\sqrt{2}$ (b) increases by a factor of 2

(c) decreases by a factor of $\sqrt{2}$ (d) decreases by a factor of 2

Ans. : (c)

Solution: $C_T \propto \frac{1}{\sqrt{V}} \Rightarrow \frac{C_T'}{C_T} = \sqrt{\frac{V}{V'}} \Rightarrow \frac{C_T'}{C_T} = \sqrt{\frac{V}{2V}} \Rightarrow C_T' = \frac{1}{\sqrt{2}} C_T$

Q40. If the parameters y and x are related by $y = \log(x)$, then the circuit that can be used to produce an output voltage V_0 varying linearly with x is



Ans. : (c)

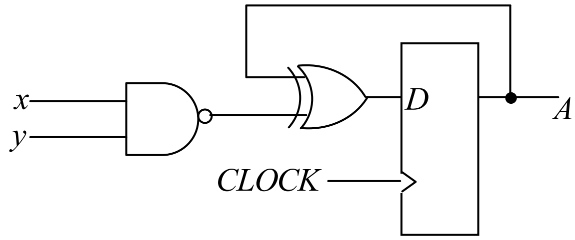
Solution: (1) Integrator

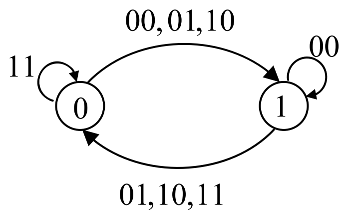
(2) Logarithmic Ampere $(V_0 \propto \log y)$

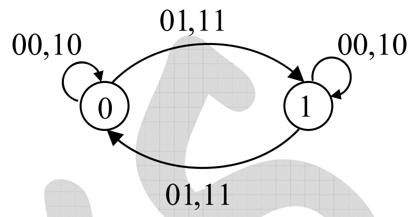
(3) Anti-log $(V_0 \propto e^y \propto x)$

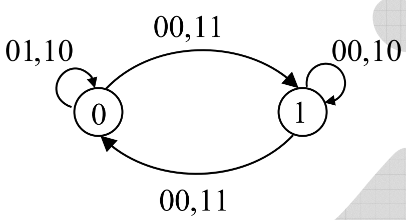
(4) Differentiator

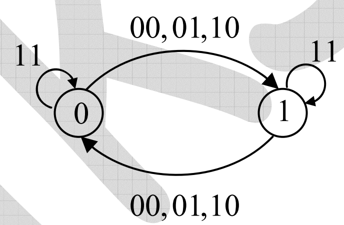
Q41. The state diagram corresponding to the following circuit is



(a)


(b)


(c)


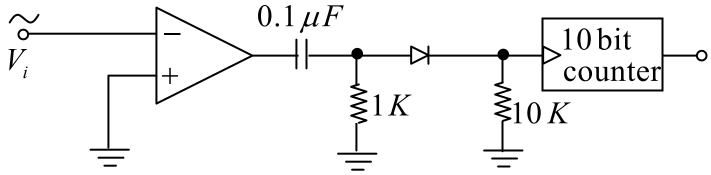
(d)


Ans. : (d)

Solution: $D_A = \overline{xy} \oplus A$

Input x y	Present State A	Flip-Flop Input D_A	Next State A
0 0	0	1	1
0 0	1	0	0
0 1	0	1	1
0 1	1	0	0
1 0	0	1	1
1 0	1	0	0
1 1	0	0	0
1 1	1	1	1

Q42. A sinusoidal signal of peak to peak amplitude $1V$ and unknown time period is input to the following circuit for 5 second's duration. If the counter measures a value $(3E8)_H$ in hexadecimal, then the time period of the input signal is



(a) $2.5\,ms$ (b) $4\,ms$ (c) $10\,ms$ (d) $5\,ms$

Ans. : (d)

Solution: $(3E8)_H \rightarrow 3\times16^2 + 14\times16 + 8\times1 = (1000)_{10}$

In 5 sec, number of counts is 1000.

Then count per sec is $= 200$ count/sec

So, $T = \frac{1}{200}\sec = 5ms$

NET/JRF (JUNE-2016)

Q43. The dependence of current I on the voltage V of a certain device is given by

$$I = I_0\left(1 - \frac{V}{V_0}\right)^2$$

where I_0 and V_0 are constants. In an experiment the current I is measured as the voltage V applied across the device is increased. The parameters V_0 and $\sqrt{I_0}$ can be graphically determined as

(a) the slope and the y-intercept of the $I - V^2$ graph

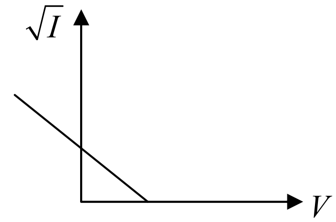
(b) the negative of the ratio of the y-intercept and the slope, and the y-intercept of the $I - V^2$ graph

(c) the slope and the y-intercept of the $\sqrt{I} - V$ graph

(d) the negative of the ratio of the y-intercept and the slope, and the y-intercept of the $\sqrt{I} - V$ graph

Ans. : (d)

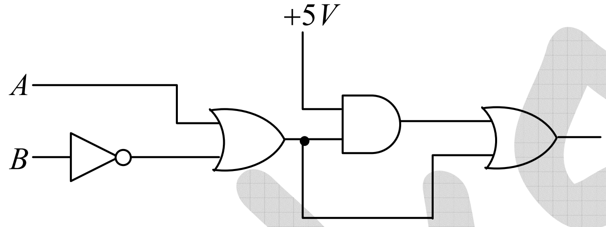
Solution: $I = I_0\left(1-\dfrac{V}{V_0}\right)^2 \Rightarrow \sqrt{I} = \sqrt{I_0}\left(1-\dfrac{V}{V_0}\right) \Rightarrow \sqrt{I} = \dfrac{-\sqrt{I_0}}{V_0}V + \sqrt{I_0}$



Slope $= \dfrac{-\sqrt{I_0}}{V_0} \Rightarrow \dfrac{-\sqrt{I_0}}{\dfrac{-\sqrt{I_0}}{V_0}} = V_0$

Intercept on y-axis $= \sqrt{I_0}$

Q44. In the schematic figure given below, assume that the propagation delay of each logic gate is t_{gate}.



The propagation delay of the circuit will be maximum when the logic inputs A and B make the transition

(a) $(0,1)\rightarrow(1,1)$ (b) $(1,1)\rightarrow(0,1)$

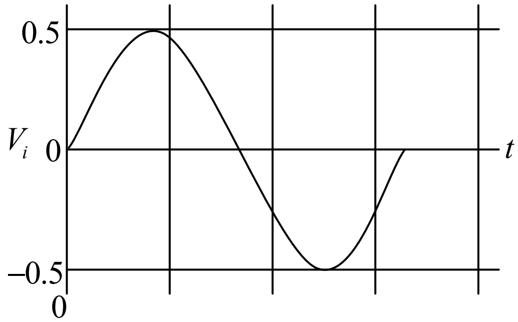
(c) $(0,0)\rightarrow(1,1)$ (d) $(0,0)\rightarrow(0,1)$

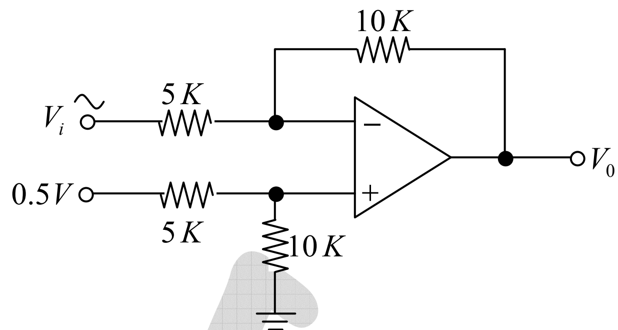
Ans. : (d)

Solution:

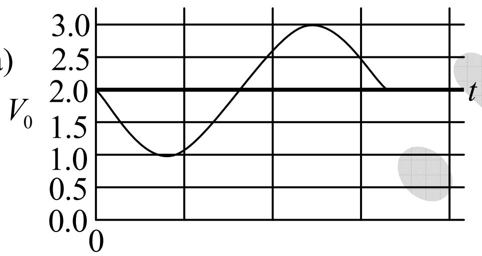
Input		Output				
A	B	NOT	OR	AND	OR	
0 1	1 1	0 $\times$ 0	0 $\downarrow$ 1	0 $\downarrow$ 1	0 $\downarrow$ 1	$3t$
1 0	1 1	0 $\times$ 0	1 $\downarrow$ 0	1 $\downarrow$ 0	1 $\downarrow$ 0	$3t$
0 1	0 1	1 $\downarrow$ 0	1 $\times$ 1	1 $\times$ 1	1 $\times$ 1	t
0 0	0 1	1 $\downarrow$ 0	1 $\downarrow$ 0	1 $\downarrow$ 0	1 $\downarrow$ 0	$4t$

Q45. Given the input voltage V_i, which of the following waveforms correctly represents the output voltage V_0 in the circuit shown below?

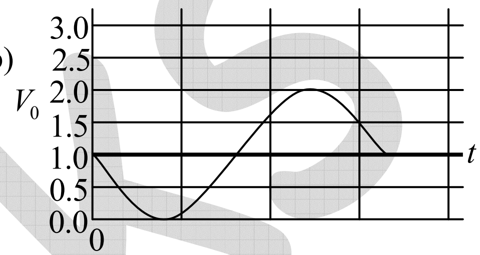




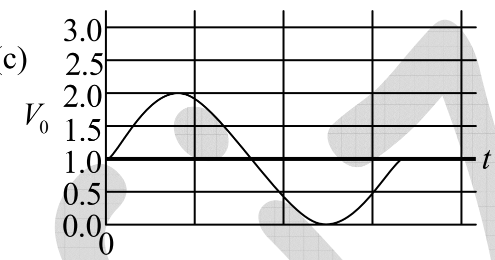
(a)



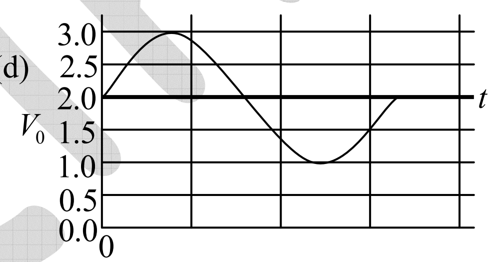
(b)



(c)



(d)



Ans. : (b)

Solution: $V_0 = \left(1+\frac{10}{5}\right)\times\frac{10}{15}\times 0.5 - \frac{10}{5}\times V_i \Rightarrow V_0 = 1-2V_i$

When $V_i = 0 \Rightarrow V_0 = 1V$, when $V_i = 0.1V \Rightarrow V_0 = 0.8\ V$, when $V_i = 0.5V \Rightarrow V_0 = 0V$

Q46. The decay constants f_p of the heavy pseudo-scalar mesons, in the heavy quark limit, are related to their masses m_p by the relation $f_p = \frac{a}{\sqrt{m_p}}$, where a is an empirical parameter to be determined. The values $m_p = (6400 \pm 160)\ MeV$ and $f_p = (180 \pm 15)\ MeV$ correspond to uncorrelated measurements of a meson. The error on the estimate of a is

(a) $175\ (MeV)^{\frac{3}{2}}$ (b) $900\ (MeV)^{\frac{3}{2}}$ (c) $1200(MeV)^{\frac{3}{2}}$ (d) $2400\ (MeV)^{\frac{3}{2}}$

Ans. : (c)

Solution: $a = f_p m_p^{1/2}$

$$\sigma_a^2 = \left(\frac{\partial a}{\partial f_p}\right)^2 \sigma_{f_p}^2 + \left(\frac{\partial a}{\partial m_p}\right)^2 \sigma_{m_p}^2 \Rightarrow \frac{\partial a}{\partial f_p} = m_p^{1/2} \text{ and } \frac{\partial a}{\partial m_p} = \frac{f_p}{2m_p^{\frac{1}{2}}}$$

$$\Rightarrow \sigma_a^2 = m_p \sigma_{f_p}^2 + \frac{f_p^2}{4m_p}\sigma_{m_p}^2 \Rightarrow \frac{\sigma_a^2}{a^2} = \left(\frac{\sigma_{f_p}}{f_p}\right)^2 + \left(\frac{\sigma_{m_p}}{2m_p}\right)^2 \Rightarrow \sigma_a = a\left[\left(\frac{\sigma_{f_p}}{f_p}\right)^2 + \left(\frac{\sigma_{m_p}}{2m_p}\right)^2\right]^{\frac{1}{2}}$$

$$\because a = f_p m_p^{1/2} = (180\ MeV)(6400\ MeV)^{1/2} = 180\times 80(MeV)^{3/2}$$

$$\left(\frac{\sigma_{f_p}}{f_p}\right)^2 = \left(\frac{15}{180}\right)^2 = 6.9\times 10^{-3} \quad \text{and} \quad \left(\frac{\sigma_{m_p}}{2m_p}\right)^2 = \left(\frac{160}{2\times 6400}\right)^2 = 1.56\times 10^{-4}$$

$$\sigma_a = 180\times 80(MeV)^{3/2}\left[6.9\times 10^{-3} + 1.56\times 10^{-4}\right]^{1/2} = 180\times 80\times\left(7\times 10^{-3}\right)^{1/2}(MeV)^{3/2}$$

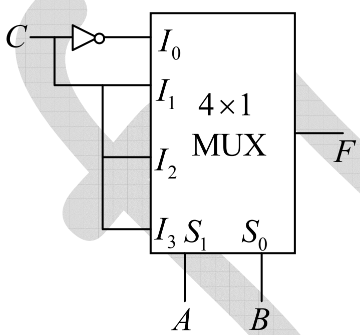
$$\Rightarrow \sigma_a = 1204(MeV)^{3/2}$$

NET/JRF (DEC-2016)

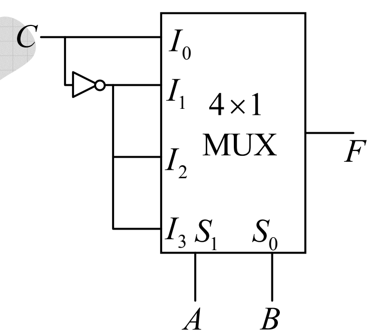
Q47. Which of the following circuits implements the Boolean function

$$F(A,B,C) = \sum(1,2,4,6)?$$

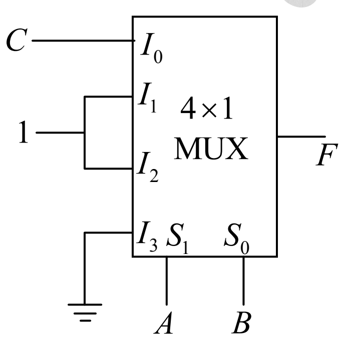
(a)



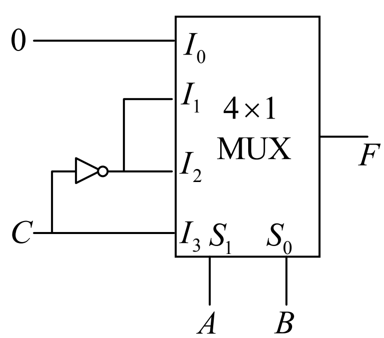
(b)



(c)



(d)



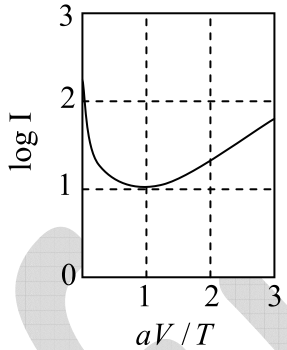
Ans. : (b)

Solution:

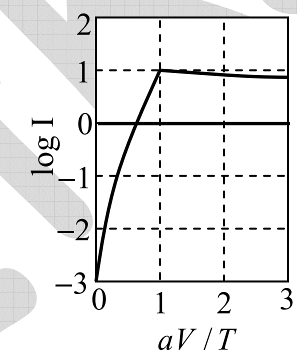
A	B	C	F	
0	0	0	0	
0	0	1	1	$F = C$
0	1	0	1	
0	1	1	0	$F = \bar{C}$
1	0	0	1	
1	0	1	0	$F = \bar{C}$
1	1	0	1	
1	1	1	0	$F = \bar{C}$

Q48. The $I - V$ characteristics of a device can be expressed as $I = I_s\left[\exp\left(\frac{aV}{T}\right) - 1\right]$, where T is the temperature and a and I_s are constants independent of T and V. Which one of the following plots is correct for a fixed applied voltage V ?

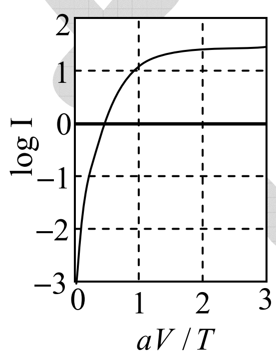
(a)



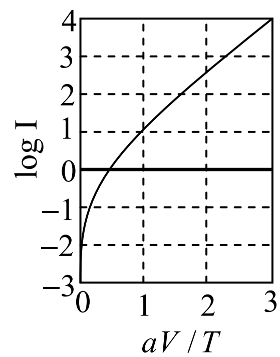
(b)



(c)



(d)



Ans. : (d)

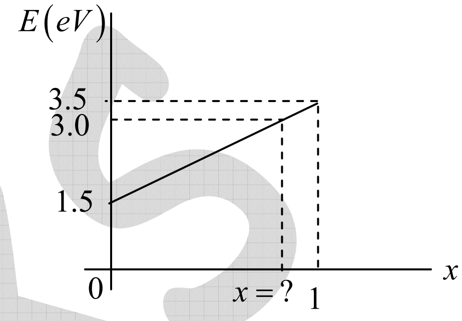
Solution: Let $\frac{av}{T} = x$ For large x; $I = I_s\ e^x \Rightarrow \log_e I = \log_e Is + x \Rightarrow \log_e I \propto x$

Q49. The active medium in a blue LED (light emitting diode) is a $Ga_xIn_{1-x}N$ alloy. The band gaps of GaN and InN are $3.5\,eV$ and $1.5\,eV$ respectively. If the band gap of $Ga_xIn_{1-x}N$ varies approximately linearly with x, the value of x required for the emission of blue light of wavelength $400\,nm$ is (take $hc \approx 1200\,eV\text{-}nm$)

(a) 0.95 (b) 0.75 (c) 0.50 (d) 0.33

Ans. : (b)

Solution: $E_{g_{GaN}} = 3.5eV$ and $E_{g_{InN}} = 1.5eV$

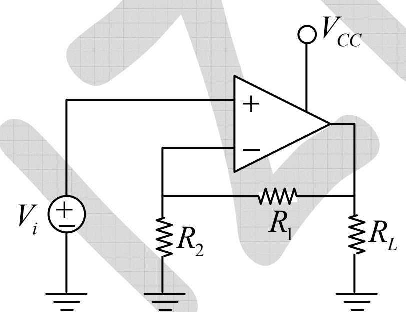


Band Gap energy of $Ga_xIn_{1-x}N$ is $E \propto x$.

For blue light of wavelength $400nm$, the band gap energy is $= \dfrac{hc}{\lambda} = \dfrac{1200\ \ eV.nm}{400nm} = 3.0eV$.

Thus equating slopes we get; $\left(\dfrac{3.5-1.5}{1-0}\right) = \left(\dfrac{3.0-1.5}{x-0}\right) \Rightarrow 2x = 1.5 \Rightarrow x = 0.75$

Q50. In the circuit below, the input voltage V_i is $2V, V_{cc} = 16V, R_2 = 2k\Omega$ and $R_L = 10\,k\Omega$

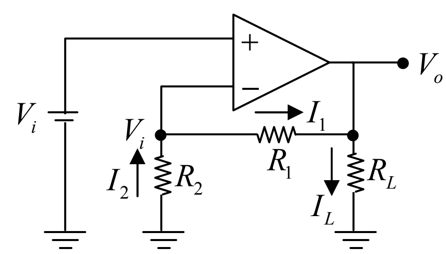


The value of R_1 required to deliver $10\,mW$ of power across R_L is

(a) $12k\Omega$ (b) $4k\Omega$ (c) $8k\Omega$ (d) $14\,k\Omega$

Ans. : (c)

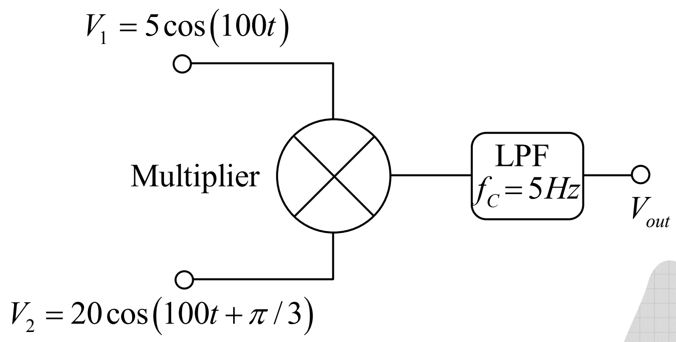
Solution: Apply kCL; $I_2 = I_1 = I_L \Rightarrow \dfrac{0-v_i}{R_2} = \dfrac{v_i - v_0}{R_1} = \dfrac{v_0 - 0}{R_L}$



$$p_L = \frac{v_0^2}{R_L} = 10mW \Rightarrow v_0 = 10V$$

$$\Rightarrow \frac{0-2}{2} = \frac{2-10}{R_1} = \frac{10V}{10k} \Rightarrow -1 = \frac{-8}{R_1} \Rightarrow R_1 = 8\,k\,\Omega$$

Q51. Two sinusoidal signals are sent to an analog multiplier of scale factor $1V^{-1}$ followed by a low pass filter (LPF).



If the roll-off frequency of the LPF is $f_c = 5\,Hz$, the output voltage V_{out} is

(a) $5V$ (b) $25V$ (c) $100V$ (d) $50V$

Ans. : (b)

Solution: After multiplying

$$5\cos(100t)\times 20\cos\left(100t+\frac{\pi}{3}\right)\times 1V^{-1} = 100\times\frac{1}{2}\left[\cos\left(200t+\frac{\pi}{3}\right)+\cos\left(\frac{-\pi}{3}\right)\right]$$

$$= 50\left[\cos\left(200t+\frac{\pi}{3}\right)+\frac{1}{2}\right]$$

After pass L.P.F. $v_0 = 50\times\frac{1}{2} = 25V$

Q52. The resistance of a sample is measured as a function of temperature, and the data are shown below.

$T(^0C)$	2	4	6	8
$R(\Omega)$	90	105	110	115

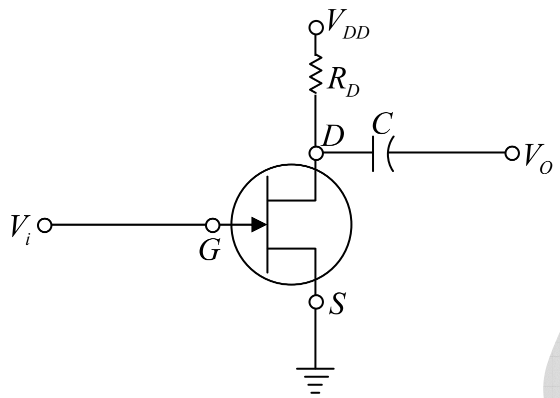
The slope of R vs T graph, using a linear least-squares fit to the data, will be

(a) $\frac{6\Omega}{^0C}$ (b) $\frac{4\Omega}{^0C}$ (c) $\frac{2\Omega}{^0C}$ (d) $\frac{8\Omega}{^0C}$

Ans. : (b)

NET/JRF (JUNE-2017)

Q53. In the n-channel JFET shown in figure below, $V_i = -2V$, $C = 10\,pF$, $V_{DD} = +16V$ and $R_D = 2k\Omega$.



If the drain D - source S saturation current I_{DSS} is $10\,mA$ and the pinch-off voltage V_P is $-8V$, then the voltage across points D and S is

(a) 11.125 V (b) 10.375 V (c) 5.75 V (d) 4.75 V

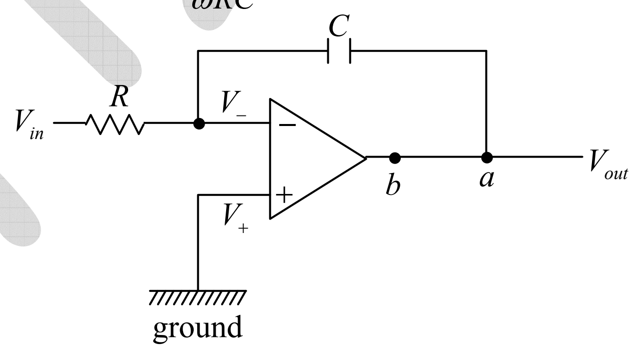
Ans. : (d)

Solution: $V_{GSQ} = -V_{GG} = -2V$

$$I_{DQ} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2 = 10mA\left(1 - \frac{-2}{-8}\right)^2 = 5.63mA$$

$$V_{DS} = V_{DD} - I_D R_D = 16 - 5.63 \times z \approx 4.8V$$

Q54. The gain of the circuit given below is $-\frac{1}{\omega RC}$.



The modification in the circuit required to introduce a dc feedback is to add a resistor

(a) between a and b

(b) between positive terminal of the op-amp and ground

(c) in series with C

(d) parallel to C

Ans. : (d)

Q55. A 2×4 decoder with an enable input can function as a

(a) 4×1 multiplexer (b) 1×4 demultiplexer

(c) 4×2 encoder (d) 4×2 priority encoder

Ans. : (b)

Q56. The experimentally measured values of the variables x and y are 2.00 ± 0.05 and 3.00 ± 0.02 respectively. What is the error in the calculated value of $z=3y-2x$ from the measurements?

(a) 0.12 (b) 0.05 (c) 0.03 (d) 0.07

Ans. : (a)

Solution: $z=3y-2x$

$$\sigma_z^2=\left(\frac{\partial z}{\partial y}\right)^2\sigma_y^2+\left(\frac{\partial z}{\partial x}\right)^2\sigma_x^2=9\sigma_y^2+4\sigma_x^2\approx0.12$$

Q57. Let I_0 be the saturation current, η the ideality factor and v_F and v_R the forward and reverse potentials respectively, for a diode. The ratio R_R/R_F of its reverse and forward resistances R_R and R_F, respectively, varies as (In the following k_B is the Boltzmann constant, T is the absolute temperature and q is the charge.)

(a) $\frac{v_R}{v_F}\exp\left(\frac{qv_F}{\eta k_BT}\right)$ (b) $\frac{v_F}{v_R}\exp\left(\frac{qv_F}{\eta k_BT}\right)$

(c) $\frac{v_R}{v_F}\exp\left(-\frac{qv_F}{\eta k_BT}\right)$ (d) $\frac{v_F}{v_R}\exp\left(-\frac{qv_F}{\eta k_BT}\right)$

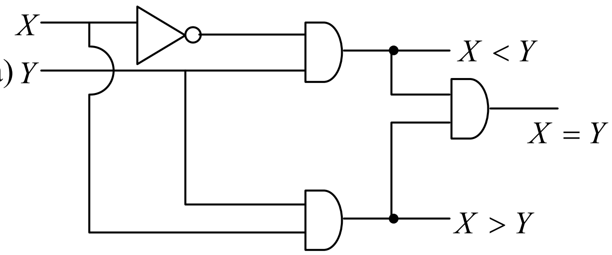
Ans. : (a)

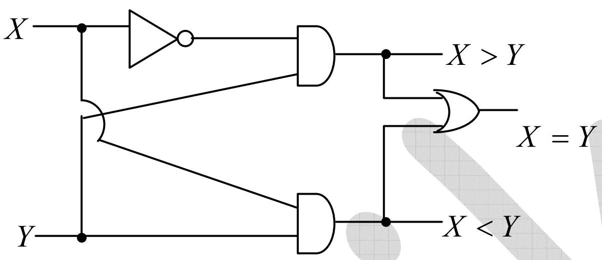
Solution: $I=I_0\left(e^{V/\eta V_T}-1\right)$, $V_T=\frac{KT}{q}$

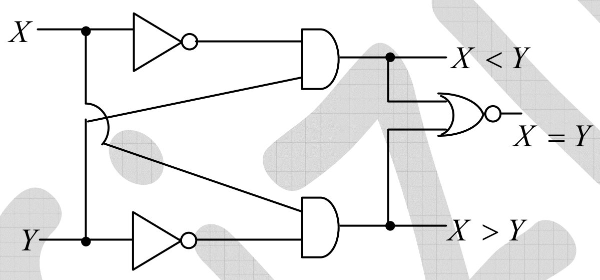
$$\frac{R_R}{R_F}=\frac{V_R/I_R}{V_F/I_F}=\frac{V_R}{V_F}\times\frac{I_F}{I_R}$$

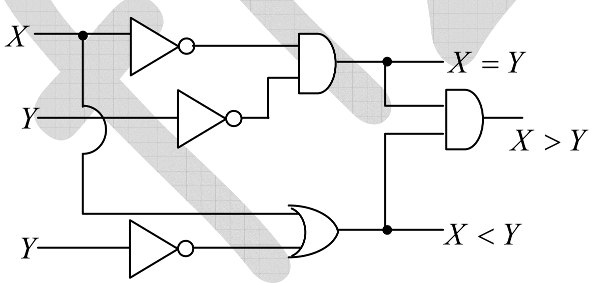
$$\Rightarrow\frac{R_R}{R_F}=\frac{V_R}{V_F}\frac{I_0e^{V_F/\eta V_T}}{I_0}=\frac{V_R}{V_F}\exp\left[\frac{qV_F}{\eta K_T}\right]$$

Q58. In the figures below, X and Y are one bit inputs. The circuit which corresponds to a one bit comparator is

(a)


(b)


(c)


(d)


Ans. : (c)

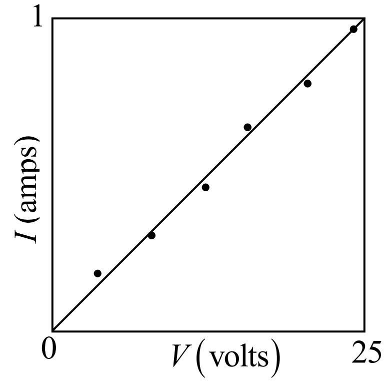
Solution: (a) $0_1 = \bar{X}Y, 0_2 = XY, 0_3 = 0$

(b). $0_1 = \bar{X}Y, 0_2 = XY, 0_3 = Y$

(c) $0_1 = \bar{X}Y, 0_2 = X\bar{Y}, 0_3 = \overline{\bar{X}Y + X\bar{Y}} = \overline{X \oplus Y}$ (Equality comparator)

(d) $0_1 = \bar{X}\bar{Y}, 0_2 = X + \bar{Y}, 0_3 = \bar{X}\bar{Y}$

Q59. Both the data points and a linear fit to the current vs voltage of a resistor are shown in the graph below.



If the error in the slope is $1.255\times10^{-3}\,\Omega^{-1}$, then the value of resistance estimated from the graph is

(a) $(0.04\pm0.8)\,\Omega$ (b) $(25.0\pm0.8)\,\Omega$

(c) $(25\pm1.25)\,\Omega$ (d) $(25\pm0.0125)\,\Omega$

Ans. : (b)

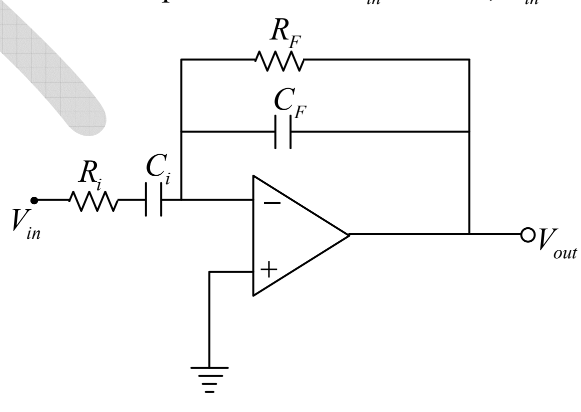
Solution: Slope $=\dfrac{I_{\max}-I_{\min}}{V_{\max}-V_{\min}}=\dfrac{1-0}{25-0}=\dfrac{1}{25}=m$ (let)

$\because I=\dfrac{V}{R}=mV \Rightarrow R=\dfrac{1}{m}=25\Omega$ where $\dfrac{\partial R}{\partial m}=-\dfrac{1}{m^2}$

Error in R is $\sigma_R^2=\left(\dfrac{\partial R}{\partial m}\right)^2\sigma_m^2=\dfrac{1}{m^4}\sigma_m^2=R^4\sigma_m^2$

$\Rightarrow \sigma_R=R^2\sigma_m=(25)^2\times1.255\times10^{-3}\approx0.8\Omega \Rightarrow R=(25.0\pm0.8)\Omega$

Q60. In the following operational amplifier circuit $C_{in}=10\,nF$, $R_{in}=20\,k\Omega$, $R_F=200\,k\Omega$ and $C_F=100\,pF$.



The magnitude of the gain at a input signal frequency of $16\,kHz$ is

(a) 67 (b) 0.15 (c) 0.3 (d) 3.5

Ans. : (d)

Solution: $\frac{V_o}{V_{in}}=-\frac{z_F}{z_i}=-\frac{R_F \parallel X_{C_F}}{R_i+X_{C_i}}=-\frac{R_F\times\frac{1}{J\omega c_F}/\left(R_F+\frac{1}{J\omega c_F}\right)}{\left(R_i+\frac{1}{J\omega c_i}\right)}$

$$\frac{V_o}{V_{in}}=\frac{-R_F/\left(J\omega c_F R_F+1\right)}{\left(j\omega c_i R_i+1\right)/j\omega c_i}=\frac{-R_F}{\left(j\omega c_F R_F+1\right)}\times\frac{j\omega c_i}{\left(1+j\omega R_i c_i\right)}$$

$$\Rightarrow\left|\frac{V_o}{V_{in}}\right|=\frac{\omega c_i R_F}{\sqrt{1+\left(\omega c_F R_F\right)^2}\sqrt{1+\left(\omega R_i c_i\right)^2}},\omega=2\pi f$$

$$\Rightarrow\left|\frac{V_0}{V_{\ln}}\right|=\frac{\left(2\pi\times16\times10^3\right)\left(10\times10^{-9}\right)\left(200\times10^3\right)}{\sqrt{1+4\pi^2\left(16\times10^3\right)^2\left(200\times10^3\right)^2\left(100\times10^{-12}\right)^2}\sqrt{1+4\pi^2\left(16\times10^3\right)^2\left(20\times10^3\right)^2\left(10\times10^{-9}\right)^2}}$$

$$\Rightarrow\left|\frac{V_0}{V_{\ln}}\right|=\frac{64\pi}{2.4\times20.12}\approx4.45$$

NET/JRF (DEC - 2017)

Q61. The full scale voltage of an n-bit Digital-to-Analog Convener is V. The resolution that can be achieved in it is

(a) $\frac{V}{\left(2^n-1\right)}$ (b) $\frac{V}{\left(2^n+1\right)}$ (c) $\frac{V}{2^{2n}}$ (d) $\frac{V}{n}$

Ans. : (a)

Q62. A Zener diode with an operating voltage of $10\ V$ at 25^0C has a positive temperature coefficient of 0.07% per ${}^0C$ of the operating voltage. The operating voltage of this Zener diode at 125^0C is

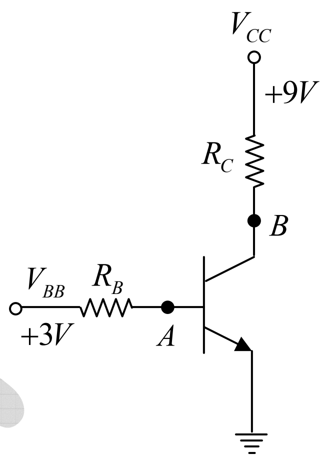
(a) $12.0\ V$ (b) $11.7\ V$ (c) $10.7\ V$ (d) $9.3\ V$

Ans. : (c)

Solution: With increase of 100^0C, the voltage increases by $=7\%$ of operating voltage

Thus at 125^0C, the operating voltage is $=\left(10+10\times\frac{7}{100}\right)V=10.7V$

Q63. In the circuit below the voltages V_{BB} and V_{CC} are kept fixed, the voltage measured at B is a constant, but that measured at A fluctuates between a few μV to a few mV.



From these measurements it may be inferred that the

(a) base is open internally

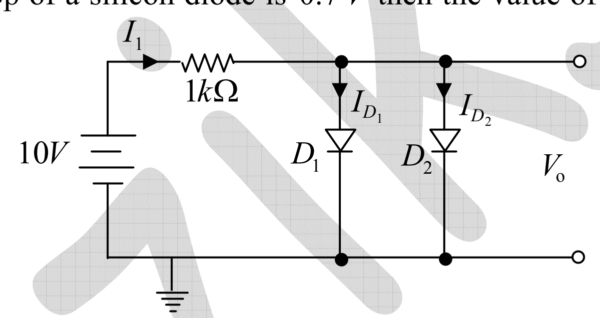
(b) emitter is open internally

(c) collector resistor is open

(d) base resistor is open

Ans. : (d)

Q64. In the circuit below, D_1 and D_2 are two silicon diodes with the same characteristics. If the forward voltage drop of a silicon diode is $0.7\ V$ then the value of the current $I_1 + I_{D_1}$ is



(a) $18.6\ mA$ (b) $9.3\ mA$ (c) $13.95\ mA$ (d) $14.65\ mA$

Ans. : (c)

Solution: $I_1 = \dfrac{10 - 0.7}{1k} = 9.3\,mA$

$$I_{D_1} = I_{D_2} = \frac{I_1}{2} \Rightarrow \left(I_1 + I_{D_1}\right) = I_1 + \frac{I_1}{2} = \frac{3}{2} I_1 = 13.95\ mA$$

Q65. The sensitivity of a hot cathode pressure gauge is $10\,\text{mbar}^{-1}$. If the ratio between the numbers of the impinging charged particles to emitted electrons is $1:10$, then the pressure

(a) $10\,\text{mbar}$ (b) 10^{-1} mbar (c) 10^{-2} mbar (d) 10^{2} mbar

Ans. : (c)

Solution: Pressure, $P = \dfrac{I^+}{I^-}\left(\dfrac{1}{S}\right)$

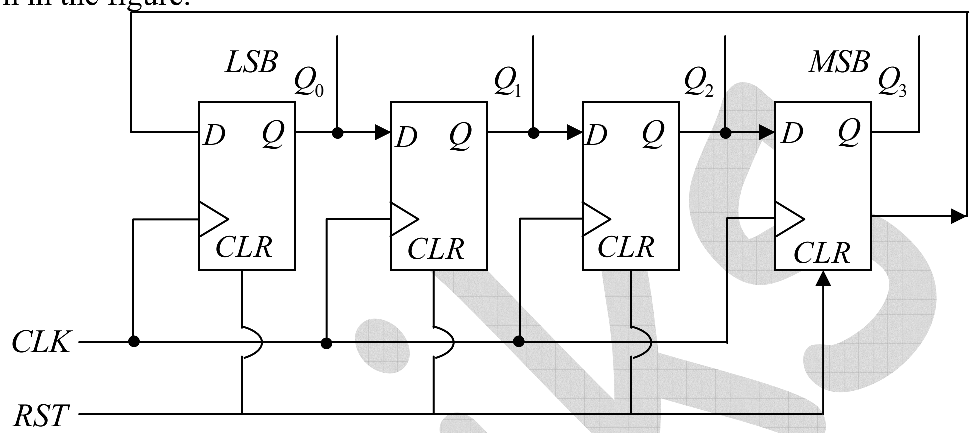
where $\dfrac{I^+}{I^-}$ = ratio between the number of the impinging charge particles to emitted electrons

$S =$ Sensitivity of Gauge.

$$\therefore\ P = \frac{1}{10}\left(\frac{1}{10\ m\,bar^{-1}}\right) = 10^{-2}\ m\,bar$$

Thus correct option is (c)

Q66. The circuit below comprises of D-flip flops. The output is taken from $Q_3, Q_{2,} Q_1$ and Q_0 as shown in the figure.



the binary number given by the string $Q_3, Q_{2,} Q_1 Q_0$ changes for every clock pulse that is applied to the CLK input. If the output is initialized at 0000, the the corresponding sequence of decimal numbers that repeats itself, is

(a) $3, 2, 1, 0$ (b) $1, 3, 7, 14, 12, 8$

(c) $1, 3, 7, 15, 12, 14, 0$ (d) $1, 3, 7, 15, 14, 12, 8, 0$

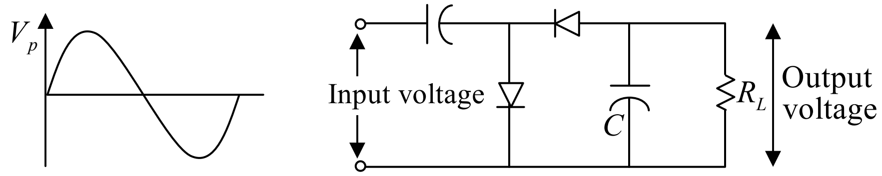
Ans. : (d)

Solution:

Clock	Q_3	Q_2	Q_1	Q_0	
	0	0	0	0	
1	0	0	0	1	1
2	0	0	1	1	3
3	0	1	1	1	7
4	1	1	1	1	15
5	1	1	1	0	14
6	1	1	0	0	12
7	1	0	0	0	8
8	0	0	0	0	0

NET/JRF (JUNE-2018)

Q67. A sinusoidal signal with a peak voltage V_p and average value zero, is an input to the following circuit.



Assuming ideal diodes, the peak value of the output voltage across the load resistor R_L is

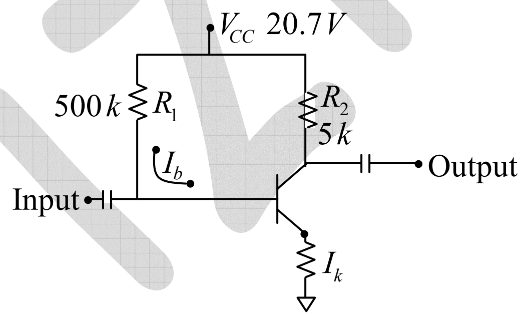
(a) V_p (b) $\frac{V_p}{2}$ (c) $2V_p$ (d) $\sqrt{2}V_p$

Ans. : (c)

Solution: It's a voltage doubler circuit

Peak value $= 2V_p$

Q68. In the following circuit, the value of the common-emitter forward current amplification factor β for the transistor is 100 and V_{BE} is $0.7V$.



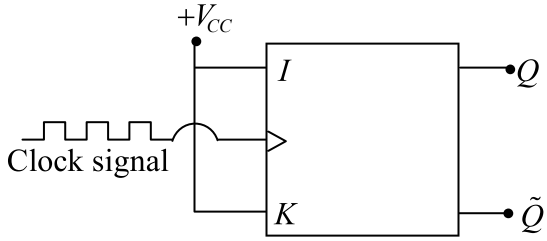
The base current I_B is

(a) 40 μA (b) 30 μA (c) 44 μA (d) 33 μA

Ans. : (d)

Solution: $I_B = \frac{V_{cc} - V_{BE}}{R_B + \beta R_E} = \frac{20.7 - 0.7}{500 + 100 \times 1} = \frac{20}{600K} = \frac{20 \times 1000}{600} \mu A = 33.3 \mu A$

Q69. In the following JK flip-flop circuit, J and K inputs are tied together to $+V_{CC}$. If the input is a clock signal of frequency f, the frequency of the output Q is



(a) f (b) $2f$ (c) $4f$ (d) $\frac{f}{2}$

Ans. : (d)

Solution: It divides clock frequency by 2

Q70. Which of the following gates can be used as a parity checker?

(a) an OR gate (b) a NOR gate

(c) an exclusive OR (XOR) gate (d) an AND gate

Ans. : (c)

Q71. Two signals $A_1 \sin(\omega t)$ and $A_2 \cos(\omega t)$ are fed into the input and the reference channels, respectively, of a lock-in amplifier. The amplitude of each signal is $1\,V$. The time constant of the lock-in amplifier is such that any signal of frequency larger than ω is filtered out. The output of the lock-in amplifier is

(a) $2\,V$ (b) $1\,V$ (c) $0.5\,V$ (d) $0\,V$

Ans. : (d)

Solution: $v = A_1 \sin \omega t . A_2 \cos \omega t = \frac{A_1 A_2}{2}\left[\sin(\omega t + \omega t) + \sin(\omega t - \omega t)\right]$

$$v = \frac{A_1 A_2}{2} \sin 2\omega t$$

This signal will be filtered out, so output is $0V$.

Q72. The full scale of a 3-bit digital-to-analog (DAC) converter is $7V$. Which of the following tables represents the output voltage of this 3-bit DAC for the given set of input bits?

(a)

Input bits	Output voltage
000	0
001	1
010	2
011	3

(b)

Input bits	Output voltage
000	0
001	1.25
010	2.5
011	3.75

(c)

Input bits	Output voltage
000	1.25
001	2.5
010	3.75
011	5

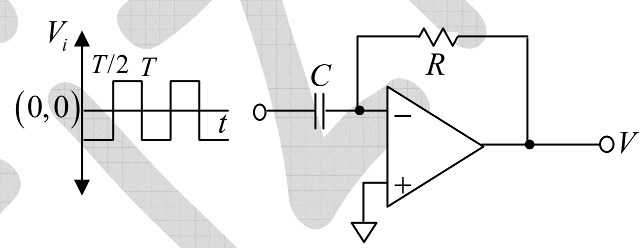
(d)

Input bits	Output voltage
000	1
001	2
010	3
011	4

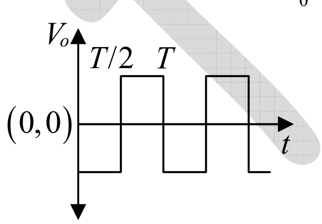
Ans. : (a)

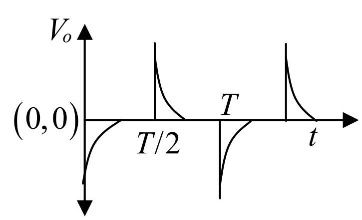
Solution: $(111)\rightarrow 7V$, $(001)\rightarrow 1V$, $(010)\rightarrow 2V$, $(011)\rightarrow 3V$, $(100)\rightarrow 4V$

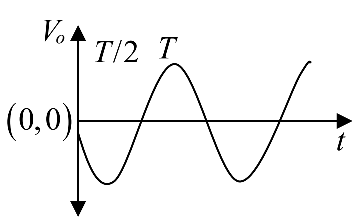
Q73. The input V_i to the following circuit is a square wave as shown in the following figure

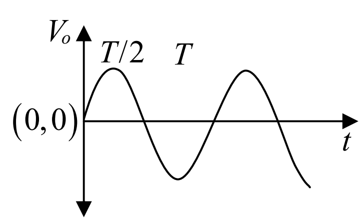


Which of the waveforms V_0 best describes the output?

(a)


(b)


(c)


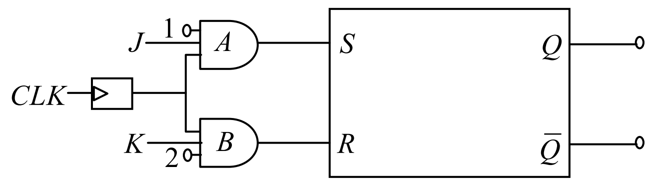
(d)


Ans. : (b)

Solution: It's a differentiator circuit

NET/JRF (DEC - 2018)

Q42. Consider the following circuit, consisting of an RS flip-flop and two AND gates.



Which of the following connections will allow the entire circuit to act as a JK flip-flop?

(a) connect Q to pin 1 and $\bar{Q}$ to pin 2

(b) connect Q to pin 2 and $\bar{Q}$ to pin 1

(c) connect Q to K input and $\bar{Q}$ to J input

(d) connect Q to J input and $\bar{Q}$ to K input

Ans. : (b)

Q43. The truth table below gives the value $Y(A, B, C)$ where A, B and C are binary variables.

The output Y can be represented by

A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	1	0	0
1	1	1	1

(a) $Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}C + AB\bar{C}$

(b) $Y = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$

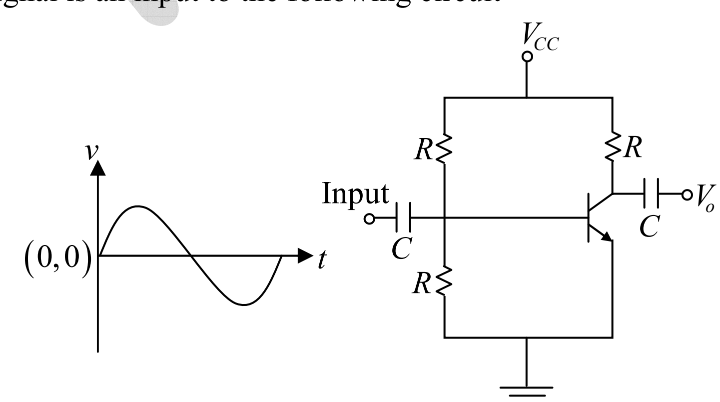
(c) $Y = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C + ABC$

(d) $Y = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$

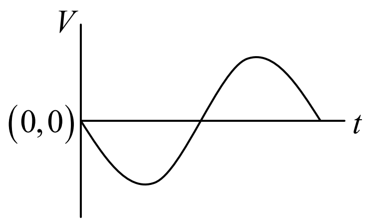
Ans. : (b)

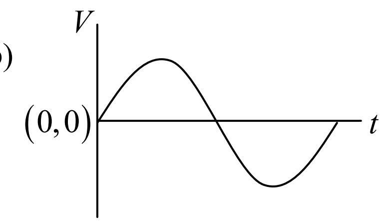
Solution: $Y = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}\bar{C} + ABC$

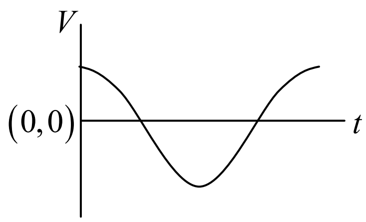
Q44. A sinusoidal signal is an input to the following circuit

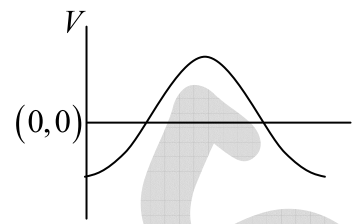


Which of the following graphs best describes the output wave function?

(a)


(b)


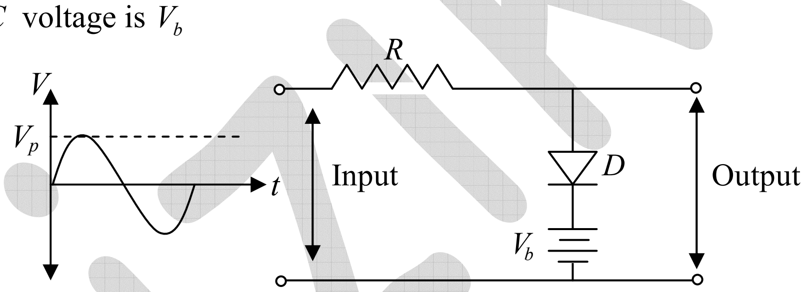
(c)


(d)


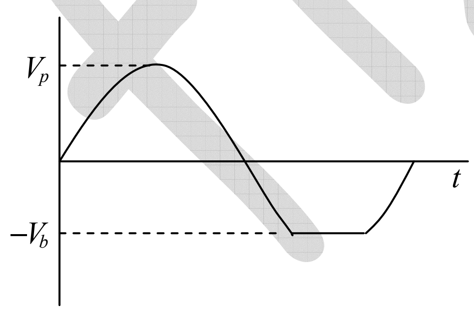
Ans. : (a)

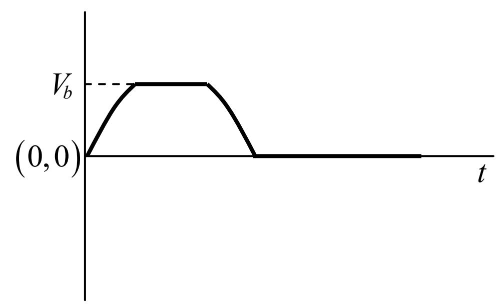
Solution: In CE transistor output has phase charge of π

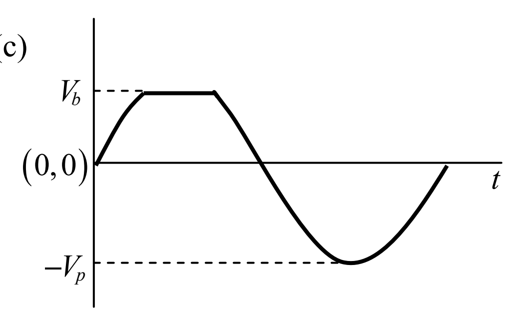
Q45. A sinusoidal voltage having a peak value of V_p is an input to the following circuit, in which the DC voltage is V_b

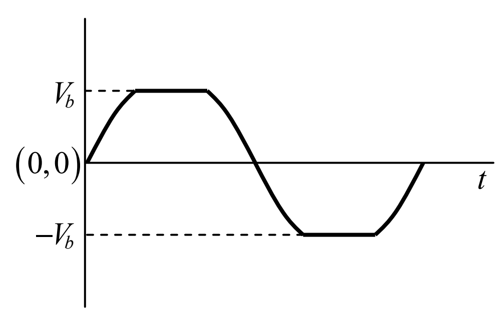


Assuming an ideal diode which of the following best describes the output waveform?

(a)


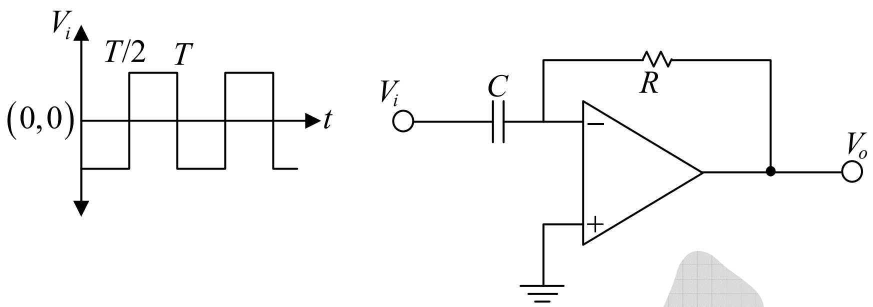
(b)


(c)


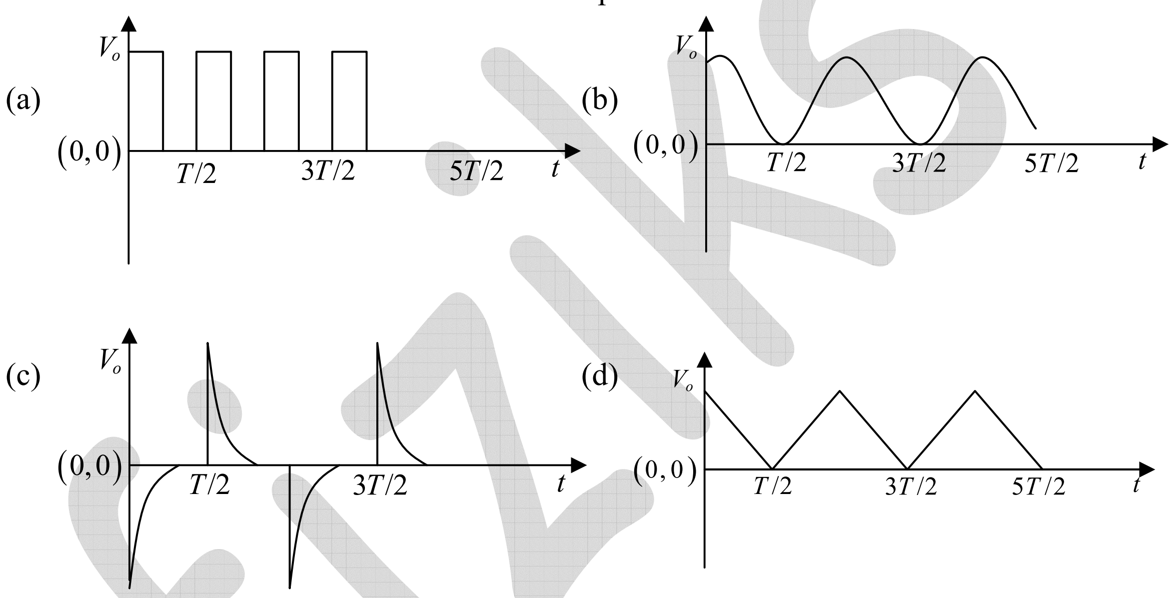
(d)


Ans. : (c)

Q64. The input V_i to the following circuit is a square wave as shown in the following figure.



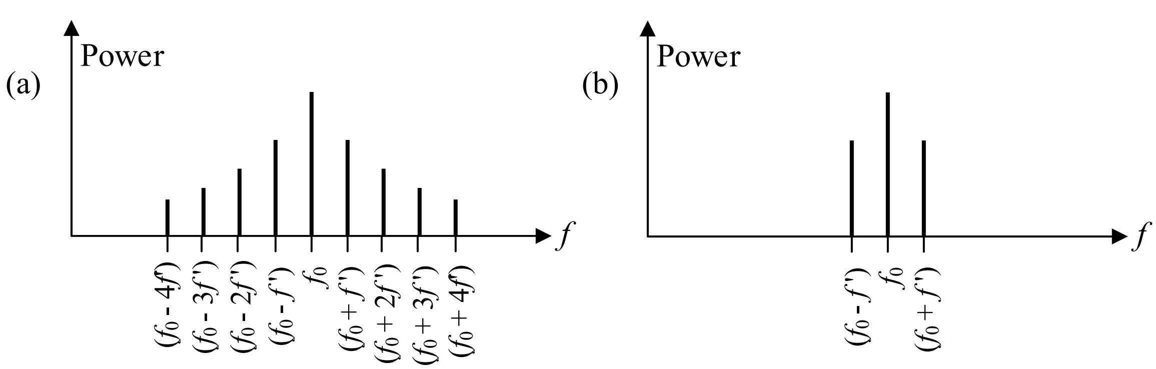
which of the waveforms best describes the output?



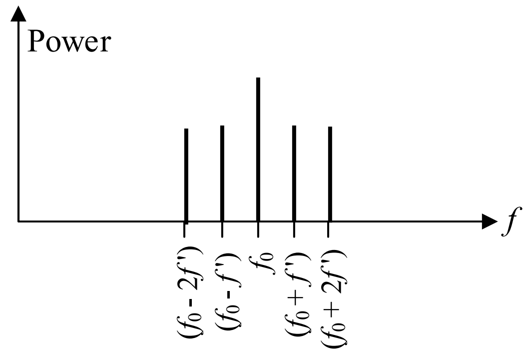
Ans. : (c)

Solution: Differentiator circuit.

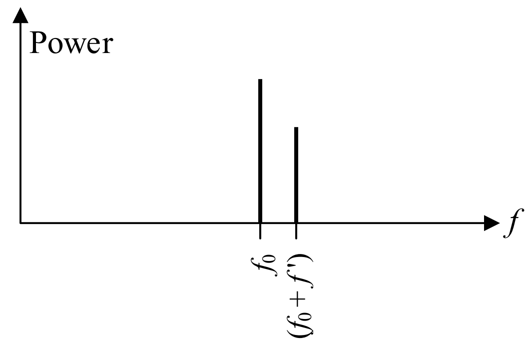
Q65. The amplitude of a carrier signal of frequency f_0 is sinusoidally modulated at a frequency $f' \ll f_0$. Which of the following graphs best describes its power spectrum?



(c)



(d)



Ans. : (b)

Solution: $2\sin A\cos B = \sin(A+B)+\sin(A-B)$

$C(t) = A\sin(2\pi ft)$ - Carrier wave

$M(t) = M\cos(2\pi f_0 t)$ -Modulation waveform

$\Rightarrow M(t) = Am\cos(2\pi f_0 t)$

Amplitude modulated wave $y(t) = \left[1+\frac{M(t)}{A}\right]C(t)$

$$y(t) = A\sin(2\pi ft)+\frac{Am}{2}\sin\left[2\pi(f+f_0)\right]+\frac{Am}{2}\sin\left[2\pi(f-f_0)\right]$$

Q66. The standard deviation of the following set of data $\{10.0,10.0,9.9,9.9,9.8,9.9,9.9,9.9,9.8,9.9\}$ is nearest to

(a) 0.10 (b) 0.07 (c) 0.01 (d) 0.04

Ans. : (b)

Solution:

x	$x_i-\overline{x}$	$(x_i-x)^2$
10.0	0.1	0.01
10.0	0.1	0.01
9.9	0	0
9.9	0	0
9.8	–0.1	0.01
9.9	0	0
9.9	0	0
9.9	0	0
9.8	–0.1	0.01
9.9	0	0
99		0.04

where $\bar{x} = \dfrac{\sum x}{N} = \dfrac{99}{10} = 9.9$

and standard deviation is

$$\sigma = \sqrt{\frac{\sum (x_i - x)^2}{N-1}} = \sqrt{\frac{0.04}{9}} = 0.066$$

$\therefore \sigma = 0.07$