Electronics

JEST-2012

Q1. The ratio of maximum to minimum resistance that can be obtained with N 1-Ω resistors is

(a) N (b) N^2 (c) 1 (d) ∞

Ans.: (b)

Solution: Resistance in series is maximum and minimum in parallel combination

$$R_s = 1+1+1+1+.....N = N$$

$$\frac{1}{R_p} = \frac{1}{1}+\frac{1}{1}+\frac{1}{1}+\frac{1}{1}+\frac{1}{1}..... = N$$

$$\frac{R_s}{R_p} = N \times N = N^2$$

Q2. The net charge of an n-type semiconductor is

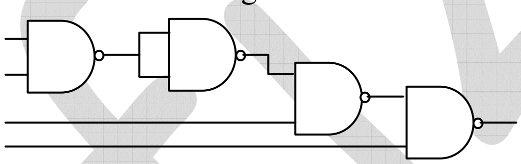
(a) positive (b) zero (c) negative (d) dependent

Ans.: (b)

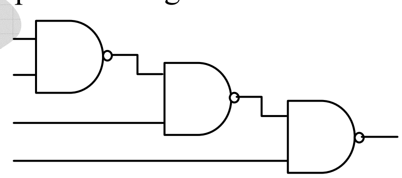
JEST-2014

Q3. Which of the following circuits will act like a 4-input NAND gate?

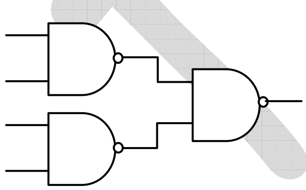
(a)



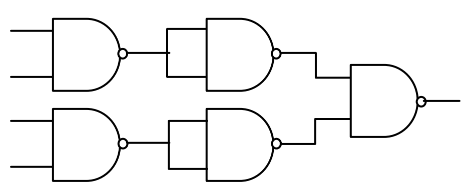
(b)



(c)

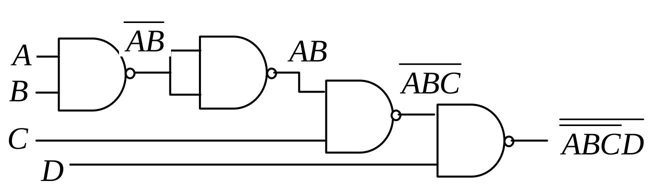


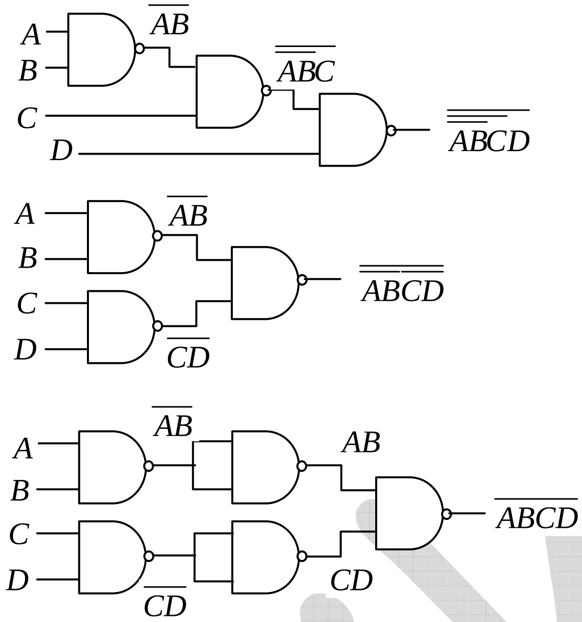
(d)



Ans.: (d)

Solution:





Q4. The formula for normal strain in a longitudinal bar is given by $\varepsilon = \frac{F}{AE}$, where F is normal force applied, A is cross-sectional area of the bar and E is Young's modulus. If $F = 50 \pm 0.5N$, $A = 0.2 \pm 0.002\, m^2$ and $E = 210 \times 10^9 \pm 1 \times 10^9$ Pa, the maximum error in the measurement of strain is

(a) 1.0×10^{-12} (b) 2.95×10^{-11} (c) 1.22×10^{-9} (d) 1.19×10^{-9}

Ans.: (b)

Solution: $\varepsilon = \frac{F}{AE} \Rightarrow \frac{\Delta\varepsilon}{\varepsilon} = \frac{\Delta F}{F} + \frac{\Delta A}{A} + \frac{\Delta E}{E} = \frac{0.5}{50} + \frac{.002}{0.2} + \frac{1 \times 10^9}{210 \times 10^9}$

$$\frac{\Delta\varepsilon}{\varepsilon} = 0.02476 \Rightarrow \Delta\varepsilon = 0.2476 \times \varepsilon = \frac{0.2476 \times 50}{0.2 \times 210 \times 10^9} = 2.95 \times 10^{-11}$$

Q5. A 100 ohms resistor carrying current of 1 Amp is maintained at a constant temperature of $30^{o}C$ by a heat bath. What is the rate of entropy increase of the resistor?

(a) 3.3 Joules/K/sec (b) 6.6 Joules/K/sec

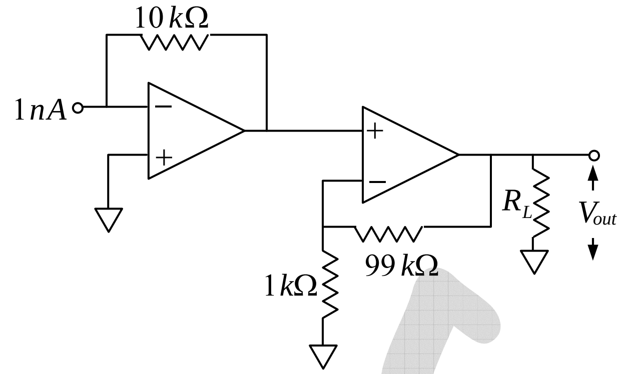
(c) 0.33 Joules/K/sec (d) None of the above

Ans.: (c)

Solution: $W = qV \Rightarrow W = itV \Rightarrow W = i^2Rt$. Now, $\frac{\partial W}{\partial T} = \frac{i^2Rt}{T} = \frac{1 \times 100}{30 + 273} = 0.33$

JEST-2015

Q6. What is the voltage at the output of the following operational amplifier circuit. [See in the figure]?



(a) $1V$

(b) $1\,mV$

(c) $1\,\mu V$

(d) $1\,nV$

Ans.: (b)

Solution: Output of first Op-Amp $v_{01} = -\left(10\times10^{3}\right)\left(1\times10^{-9}\right) = -10^{-5}\,volt$

Output of first Op-Amp $v_{out} = \left(1+\frac{99}{1}\right)\times10^{-5} = 10^{-3}\,volts = 1\,mV$

Q7. The reference voltage of an analog to digital converter is $1\,V$. The smallest voltage step that the converter can record using a 12-bit converter is,

(a) $0.24V$ (b) $0.24\,mV$ (c) $0.24\,\mu V$ (d) $0.24\,nV$

Ans.: (b)

Solution: Smallest voltage step $= \frac{1}{2^{12}-1} \approx 0.24\,mV$

Q8. In Millikan's oil drop experiment the electronic charge e could be written as $k\eta^{1.5}$, where k is a function of all experimental parameters with negligible error. If the viscosity of air η is taken to be 0.4% lower than the actual value, what would be the error in the calculated value of e?

(a) 1.5% (b) 0.7% (c) 0.6% (d) 0.4%

Ans.: (d)

Solution: Electronic charge is proportional to the viscosity i.e. $e = k\eta^{1.5} = k\eta^{3/2}$

Now error in the measurement of charge is $\sigma_e^2 = \left(\frac{\partial e}{\partial \eta}\right)^2 \sigma_\eta^2$

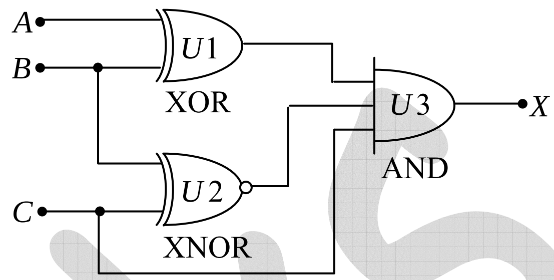
$$\Rightarrow \sigma_e = \left(\frac{\partial e}{\partial \eta}\right)\sigma_\eta, \text{ where } \frac{\partial e}{\partial \eta} = \frac{3}{2}k\eta^{1/2}$$

$$\therefore \sigma_e = \left(\frac{3}{2}k\eta^{1/2}\right)\sigma_\eta = \frac{3}{2}k\eta^{3/2}\frac{\sigma_\eta}{\eta} = \frac{3}{2}e\frac{\sigma_\eta}{\eta} \Rightarrow \frac{\sigma_e}{e} = \frac{3}{2}\frac{\sigma_\eta}{\eta}$$

Given $\frac{\sigma_\eta}{\eta} = 0.4\%$

$\therefore \frac{\sigma_e}{e} = \frac{3}{2} \times 0.4\% = 0.6\%$. Thus correct answer is option (c).

Q9. For the logic circuit shown in figure, the required input condition (A, B, C) to make the output $(X) = 1$ is,



(a) 1,0,1

(b) 0,0,1

(c) 1,1,1

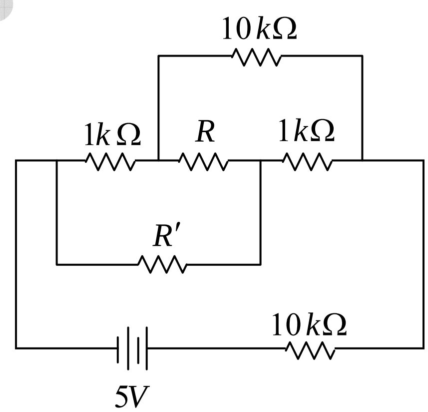
(d) 0,1,1

Ans.: (d)

Solution: XOR is inequality comparator and XNOR is equality comparator. In AND gate output will be high when all the input is 1.

JEST-2016

Q10. It is found that when the resistance R indicated in the figure below is changed from 1 $k\Omega$ to 10 $k\Omega$ the current flowing through the resistance R' does not change. What is the value of the resistor R'?



(a) 5 $k\Omega$

(b) 100 $k\Omega$

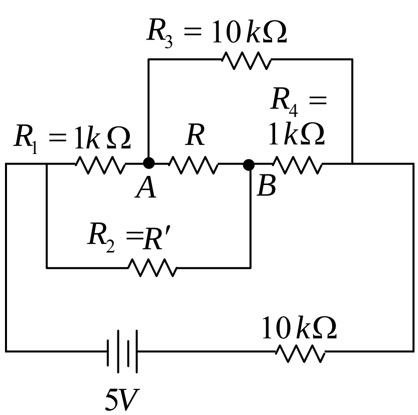
(c) 10 $k\Omega$

(d) 1 $k\Omega$

Ans.: (b)

Solution: Apply Wheatstone bridge condition

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \Rightarrow \frac{1}{R'} = \frac{10}{1}$$



Q11. A transistor in common base configuration has ratio of collector current to emitter current β and ratio of collector to base current α. Which of the following is true?

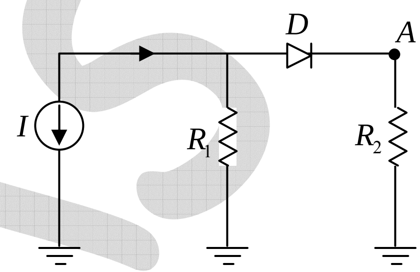
(a) $\beta = \dfrac{\alpha}{(\alpha+1)}$ (b) $\beta = \dfrac{(\alpha+1)}{\alpha}$ (c) $\beta = \dfrac{\alpha}{(\alpha-1)}$ (d) $\beta = \dfrac{(\alpha-1)}{\alpha}$

Ans.: (a)

Solution: $\because I_E = I_C + I_B \Rightarrow \dfrac{I_E}{I_C} = 1 + \dfrac{I_B}{I_C} \Rightarrow \dfrac{1}{\beta} = 1 + \dfrac{1}{\alpha} \Rightarrow \beta = \dfrac{\alpha}{1+\alpha}$

JEST - 2017

Q12. Consider the circuit shown in the figure where $R_1 = 2.07\,k\Omega$ and $R_2 = 1.93\,k\Omega$. Current source I delivers $10\,mA$ current. The potential across the diode D is $0.7V$. What is the potential at A?

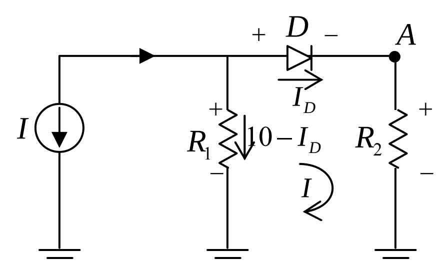


(a) $10.35V$ (b) $9.65V$

(c) $19.30V$ (d) $4.83V$

Ans. : (b)

Solution: Apply KVL in loop I

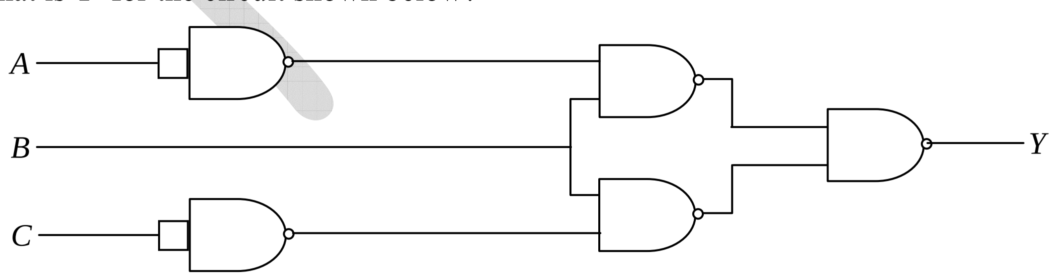


$$0.7 + I_D R_2 - (10 - I_D) R_1 = 0$$

$$\Rightarrow 0.7 + I_D \times 1.93 - (10 - I_D) \times 2.07 = 0$$

$$\Rightarrow I_D = 5\,mA \Rightarrow V_A = I_D R_2 = 5\,mA \times 1.93\,k\Omega = 9.65V$$

Q13. What is Y for the circuit shown below?

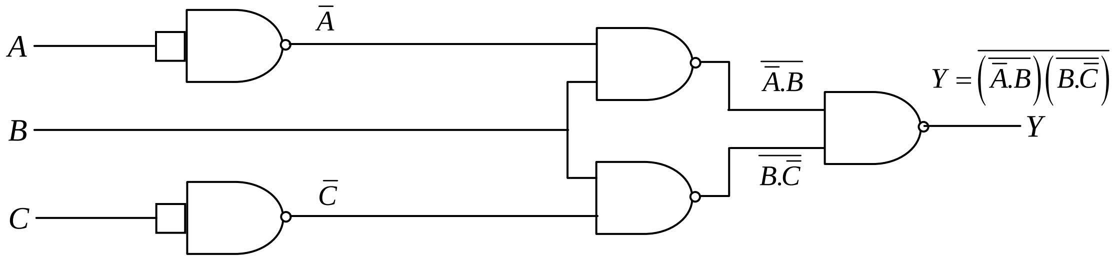


(a) $Y = \overline{(A+\bar{B})(\bar{B}+C)}$ (b) $Y = \overline{(A+\bar{B})(B+C)}$

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

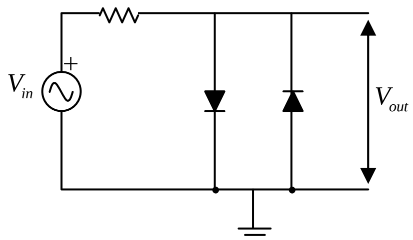
Ans.: (a)

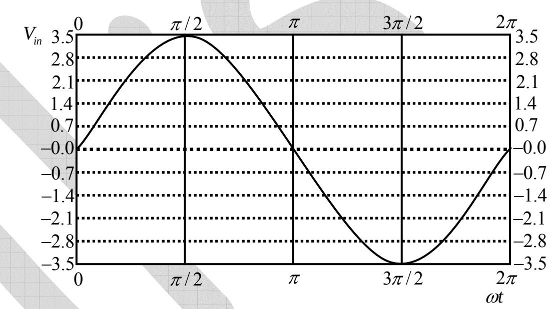
Solution:

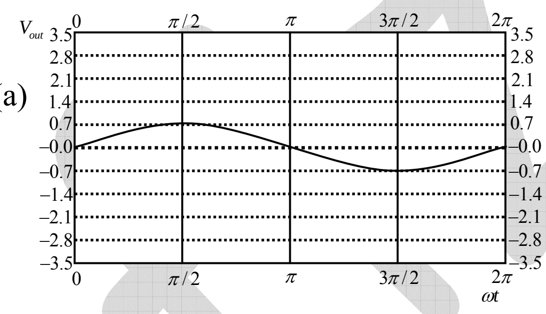


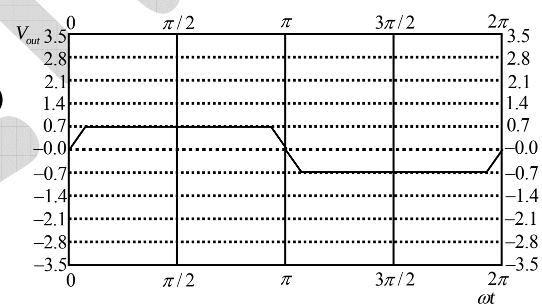
$$Y = \overline{\left(\overline{\overline{A}.B}\right).\left(\overline{B.\overline{C}}\right)} = \overline{\left(A+\overline{B}\right)\left(\overline{B}+C\right)}$$

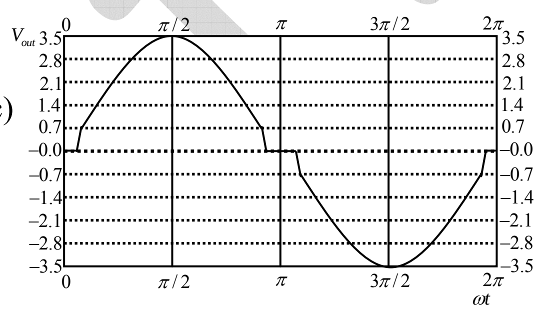
Q14. In the following silicon diode circuit $\left(V_B = 0.7V\right)$, determine the output voltage waveform $\left(V_{out}\right)$ for the given input wave.

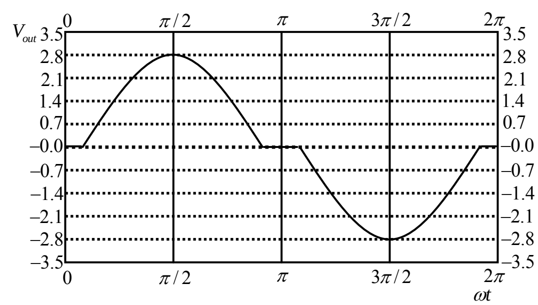




(a)


(b)


(c)


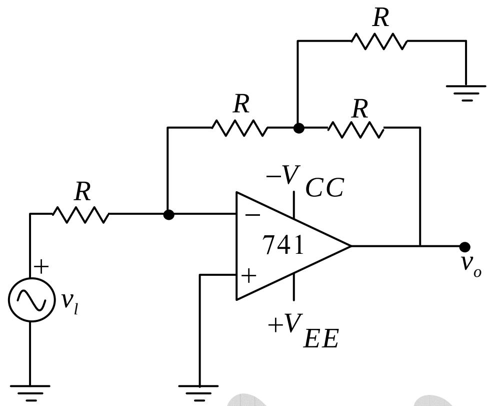
(d)


Ans.: (b)

Solution: Transition voltage $V_T = \pm 0.7V$

When diodes are ON, output voltage will be either $+0.7V$ and $-0.7V$.

Q15. Consider a 741 operational amplifier circuit as shown below, where $V_{CC} = V_{EE} = +15V$ and $R = 2.2\,k\Omega$. If $v_I = 2mV$, what is the value of v_0 with respect to the ground?



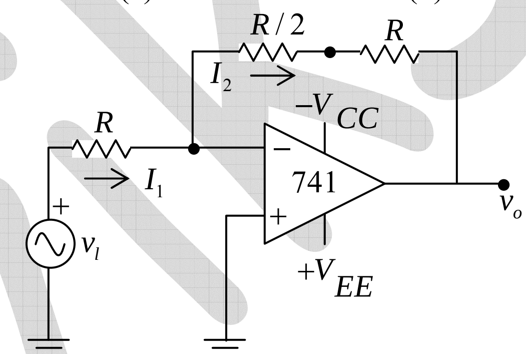
(a) $-1\,mV$ (b) $-2\,mV$ (c) $-3\,mV$ (d) $-4\,mV$

Ans. : (c)

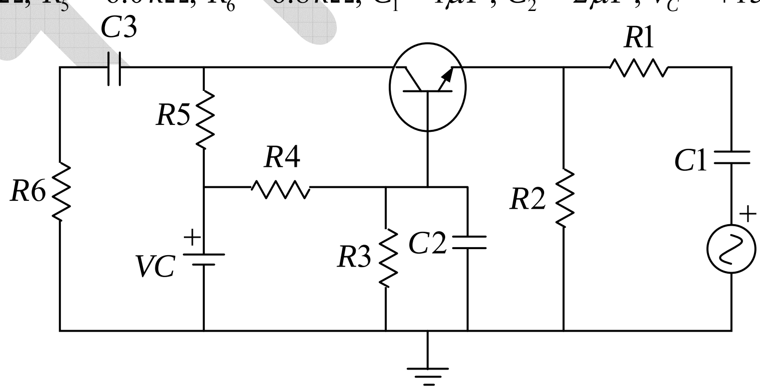
Solution: Apply KCL;

$$I_1 = I_2 \Rightarrow \frac{v_i - 0}{R} = \frac{0 - v_0}{3R/2}$$

$$\Rightarrow v_0 = -\frac{3}{2}v_i = -\frac{3}{2}\times 2 = -3\,mV$$



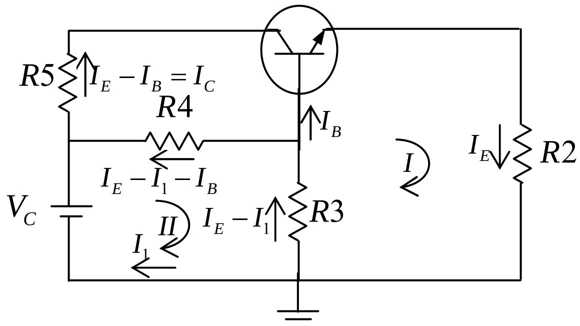
Q16. What is the DC base current (approximated to nearest integer value in μA) for the following n - p - n silicon transistor circuit, given $R_1 = 75\,\Omega, R_2 = 4.0\,k\Omega, R_3 = 2.1\,k\Omega,$ $R_4 = 2.6\,k\Omega,\ R_5 = 6.0\,k\Omega,\ R_6 = 6.8\,k\Omega,\ C_1 = 1\mu F,\ C_2 = 2\mu F,\ V_C = +15V\ \beta_{dc} = 75$?



(a) 20 (b) 24 (c) 16 (d) 32

Ans. : (a)

Solution:



Apply KVL in Loop I; $I_E R_2 + (I_E - I_1)R_3 + V_{BE} = 0$

Apply KVL in Loop II; $-V_C - (I_E - I_1 - I_B)R_4 - (I_E - I_1)R_3 = 0$

$$-V_C - (I_E - I_1)R_4 - (I_E - I_1)R_3 = 0 \Rightarrow I_E - I_1 = -\frac{V_C}{R_3 + R_4}$$

From Loop I; $\beta I_B R_2 - \frac{V_C}{R_3 + R_4}R_3 = 0 \Rightarrow I_B = \frac{V_C}{R_3 + R_4}\frac{R_3}{\beta R_2}$ $\quad \because V_{BE} = 0$

$$\Rightarrow I_B = \frac{15}{2.1 + 2.6}\frac{2.1}{75 \times 4} \approx 21\,\mu A$$

JEST-2018

Q17. A Germanium diode is operated at a temperature of 27 degree C. The diode terminal voltage is $0.3\,V$ when the forward current is $10\,mA$. What is the forward current (in mA) if the terminal voltage is $0.4\,V$?

(a) 477.3 (b) 577.3 (c) 47.73 (d) 57.73

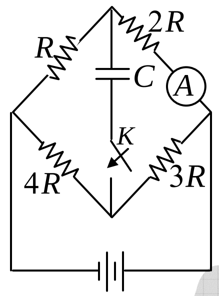
Ans. : (a)

Solution: $I = I_0\left(e^{V/V_T} - 1\right) \approx I_0 e^{V/V_T}$ where $V_T = \frac{kT}{e} = 0.026V$

$$\Rightarrow 10\,mA = I_0 e^{0.3/0.026} = I_0 e^{11.54} \Rightarrow I_0 = \frac{10}{102744}mA$$

Thus, $I = I_0 e^{0.4/0.026} = \frac{10}{102744} \times 4876800\ mA \approx 474.6\ mA$

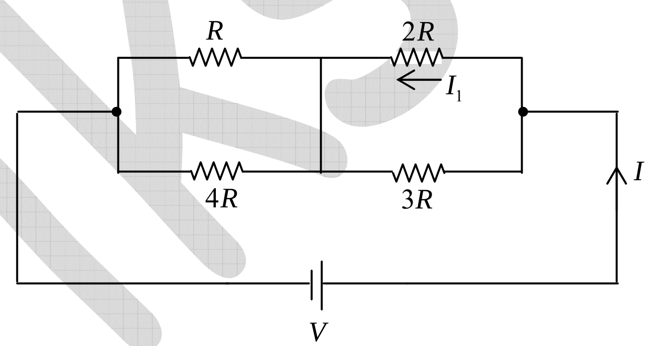
Q18. In the circuit shown below, the capacitor is initially uncharged. Immediately after the key K is closed, the reading in the ammeter is $27\ mA$.



What will the reading (in mA) be a long time later?

Ans. : 30

Solution: Immediately after the key K is closed, capacitor is short circuited. Using KCL



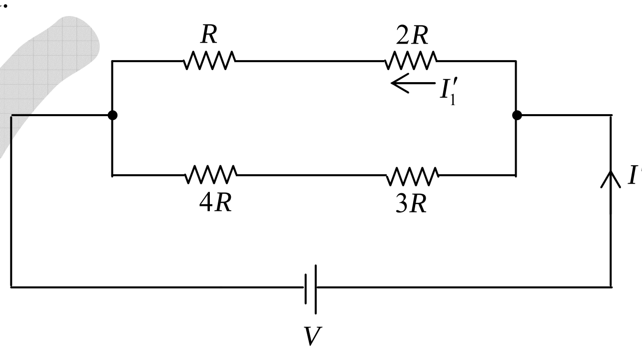
$$I_1 = \frac{3R}{5R} \times I = 27\,mA \Rightarrow I = 45\,mA.$$

$$R_{eq} = \frac{2R \times 3R}{5R} + \frac{R \times 4R}{5R} = 2R$$

Thus $V = IR_{eq} = 90R$

After long time, capacitor is open circuited.

Using KCL

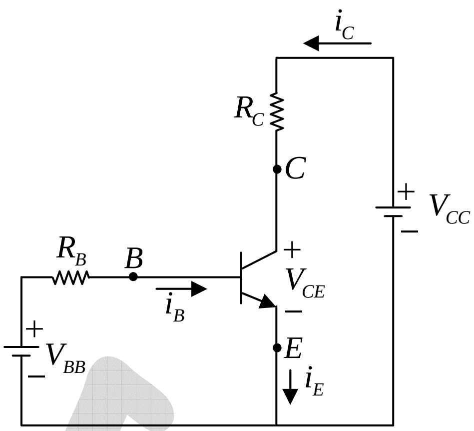


$$R_{eq} = \frac{3R \times 7R}{10R} = \frac{21}{10}R$$

$$I' = \frac{V}{R_{eq}} = \frac{90R}{21R/10} = \frac{300}{7}mA$$

$$I_1' = \frac{7R}{10R} \times \frac{300}{7}mA = 30\,mA.$$

Q19. Consider the transistor circuit shown in the figure. Assume $V_{BEQ} = 0.7\,V, V_{BB} = 6V$ and the leakage current is negligible. What is the required value of R_B in kilo-ohms if the base current is to be $4\,\mu A$?



Ans. : 1325

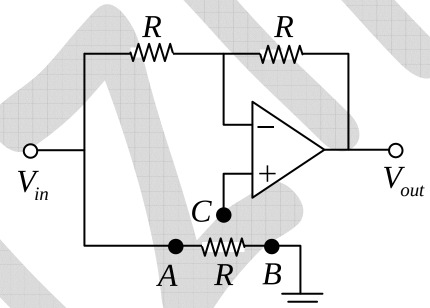
Solution: Apply LVL in input section

$$-V_{BB} + I_B R_B + V_{BE} = 0$$

$$\Rightarrow R_B = \frac{V_{BB} - V_{BE}}{I_B} = \frac{6V - 0.7V}{4\times 10^{-3}\,mA}(k\Omega) = 1325\,k\Omega$$

JEST-2019

Q20. Analyse the ideal op-amp circuit in the figure. Which one of the following statements is true about the output voltage V_{out}, when terminal 'C' is connected to point 'A' and then to point 'B'?



(a) $V_{\text{out}} = V_{\text{in}}$ and $V_{\text{out}} = -V_{in}$ when 'C' is connected to 'A' and 'B', respectively

(b) $V_{\text{out}} = -V_{in}$ and $V_{\text{out}} = V_{\text{in}}$ when 'C' is connected to 'A' and 'B', respectively

(c) $V_{\text{out}} = -V_{in}$ when 'C' is connected to either 'A' or 'B'

(d) $V_{\text{out}} = V_{\text{in}}$ when 'C' is connected to either 'A' or 'B'

Ans. : (a)

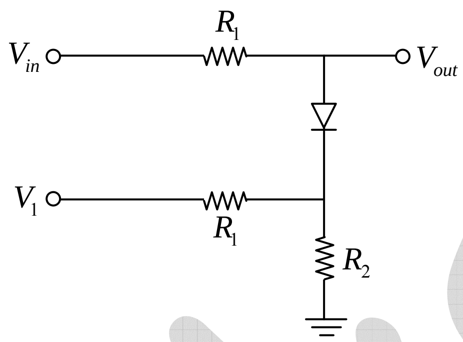
Solution: When terminal 'C' is connected to point 'A'

$$V_{\text{out}} = \left(1 + \frac{1}{1}\right)V_{\text{in}} - \frac{1}{1}V_{\text{in}} = V_{\text{in}}$$

When terminal 'C' is connected to point 'B'

$$V_{\text{out}} = -\frac{1}{1}V_{\text{in}} = -V_{\text{in}}$$

Q21. The circuit given below is fed by a sinusoidal voltage $V_{in} = V_0 \sin\omega t$. Assume that the cut-in voltage of the diode is 0.7 volts and V_1 is a positive dc voltage smaller than V_0. Which one of the following statements is true about V_{out}?



(a) Positive part of V_{out} is restricted to a maximum voltage of $0.7 + \frac{R_2}{R_1 + R_2} V_1$

(b) Negative part of V_{out} is restricted to a maximum voltage of $0.7 + \frac{R_2}{R_1 + R_2} V_1$

(c) Positive part of V_{out} is restricted to a maximum voltage of $0.7 + \frac{R_1}{R_1 + R_2} V_1$

(d) Negative part of V_{out} is restricted to a maximum voltage of $0.7 + \frac{R_1}{R_1 + R_2} V_1$

Ans. : (a)

Solution: Reference voltage $V_R = \frac{R_2}{R_1 + R_2} V_1$ and diode will be ON when $V_{in} > \left(0.7 + \frac{R_2}{R_1 + R_2} V_1\right)$.