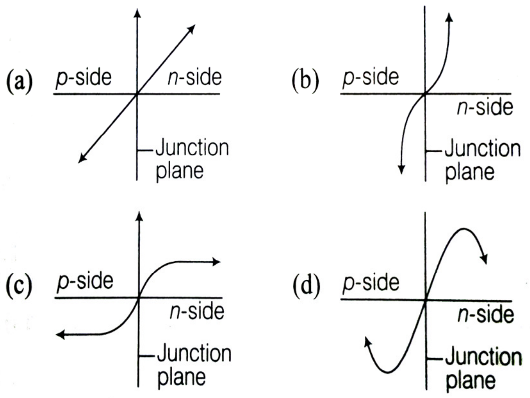
10. A silicon specimen is made into a p- type semiconductor by doping on an average , one indium atom per 5×10^7 silicon atoms. If the number density of atoms in the silicon specimen 5×10^{28} atoms / m^3 , then the number of acceptor atoms in silicon per cubic centimeter will be

(a) $2.5 \times 10^{30} atoms\ per\ cm^3$
(b) $1.0 \times 10^{13} atoms\ per\ cm^3$
(c) $1.0 \times 10^{15} atoms\ per\ cm^3$
(d) $2.5 \times 10^{36} atoms\ per\ cm^3$

11. The number of density of electrons and holes in pure silicon at 27^oC are equal and its value is $2.0\times 10^9 m^{-3}$ on doping with indium the hole density increases to $4.5\times 10^{22} m^{-3}$, the electron density in doped silicon is

(a) $10\times 10^9 m^{-3}$ (b) $8.89 \times 10^9 m^{-3}$
(c) $11 \times 10^9 m^{-3}$ (d) $16.78 \times 10^9 m^{-3}$

12. Which of these graph shown potential show potential difference between p-side and n-side of a p-n junction in equilibrium ?



13. The barrier potential of a p-n junction depends on
(i) Type of semiconductor material
(ii) Amount of doping
(iii) Temperature

Which one of the following is correct ?

(a) (i) and (ii) (b) (ii)
(c) (ii) and (iii) (d) (i) , (ii) and (iii)

14. A Si based p-n junction has a depletion layer of thickness 1 μm and barrier potential difference of n- side and p-side is 0.6 V .

(a) 0.6 Vm^{-1} (b) $6 \times 10^{-4} Vm^{-1}$
(c) $6 \times 10^5 Vm^{-1}$ (d) $6 \times 10^4 Vm^{-1}$

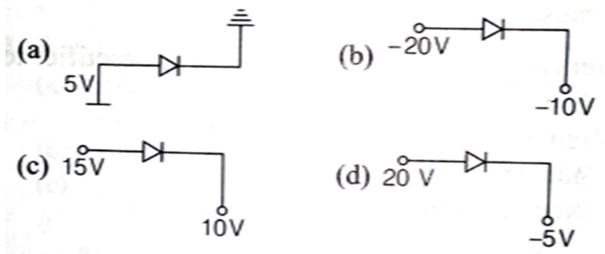
15. If V is applied potential difference in forward bias and V_0 is barrier potential of a p-n junction , then effective barrier height under forward bias is

(a) V - V_0 (b) V_0 - V (c) V_0 - V (d) V_0

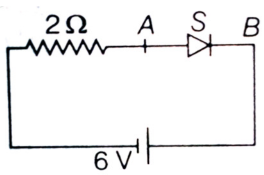
16. Dynamic resistance of a diode is given by

(a) $r_d = \frac{\Delta V}{\Delta I}$
(b) $r_d = - \frac{\Delta V}{\Delta I}$
(c) $r_d = \frac{Threshold\ voltage}{Current}$
(d) $r_d = \frac{Breakdown\ voltage}{Current}$

17. Which is reverse biased diode?

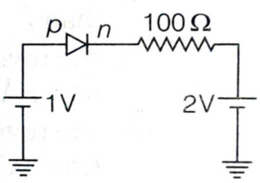


18. The diode shown in the circuit is a silicon diode. The potential difference between the points A and B will be



(a) 6 V (b) 0.6 V (c) 0.7 V (d) 0V

19. The current through an ideal p-n junction shown in the following circuit diagram will be

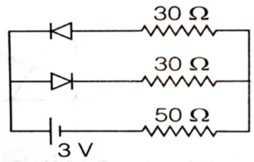


(a) zero (b) 1 mA (c) 10mA (d) 30 mA

20. When the voltage drop across a p-n junction diode is increased from 0.65 V to 0.70 V , the change in the diode current is 5 mA. The dynamic resistance of diode is

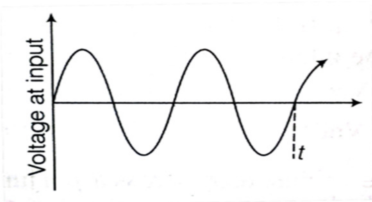
(a) 5 Ω (b) 10 Ω (c) 20 Ω (d) 25 Ω

21. The circuit shown in the figure contains two diode each with a forward resistance of 30 Ω and with infinite backward resistance . If the battery is 3V , the current through the 50 Ω resistance (in ampere)is

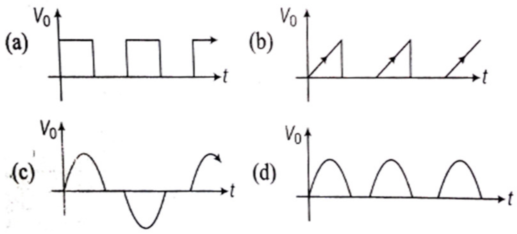


(a) 0 (b) 0.01 (c) 0.02 (d) 0.03

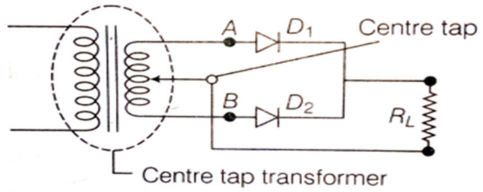
22. Input to an half- wave rectifier is given as follows



Input will be

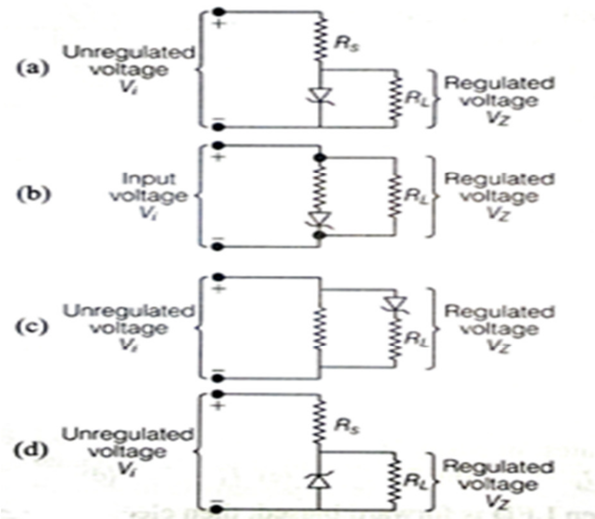


23. In the course of rectification of AC cycle when the voltage at A (upper diode input) becomes negative with respect to centre tap , the voltage at B (lower diode input) Would be positive . This implies voltage drop between A and centre tap is half- If a centre tap transformer is used with 2 diodes for full - wave refraction , then output voltage of rectifier is



(a) 2 × secondary voltage of transformer
(b) 2/3 × secondary voltage of transformer
(c) 1/2 × secondary voltage of transformer
(d) 3/2 × secondary voltage of transformer

24. Correct circuit using a zener diode as a voltage



25. When LED is forward biased , then electrons move from n to p and electron - hole combination occurs near junction plane . If E_g is energy gap between conduction band and valence band , then released energy (E) due to electron - hole combination will be

(a) $E = E_g$ (b) $E > E_g$ (c) $E \leq E_g$ (d) $E \geq E_g$

26. Semiconductors used to fabricate LED to produce visible light must have energy gap E_g such that

(a) 1.1 $eV < E_g$
(b) $E_g >$ 3 eV
(c) 1.8 $eV < E_g <$ 3 eV
(d) 1.1 $eV < E_g <$ 2.8 eV

27. To fabricate solar cell , material used have an energy gap of

(a) around 0.7 eV (b) less than 1 eV
(c) around 1.5 eV (d) less than 0.7 eV

28. A p-n junction photodiode is fabricated from semiconductor with a band gap of 2. 8 eV . It can detect a wavelength nearing to

(a) 5200 Å (b) 4400 Å (c)6200 Å (d) 7500Å

29. For a photodiode , the conductivity increases when a wavelength less than 620 nm is incident on it . The band gap of crystal used to fabricate the diode is

(a) 1.12 eV (b) 1.8 eV (c) 2.0 eV (d) 1.62eV

30. Two different semiconductors A and B are used to make 'red' and 'violet' LED's respectively . Then , ratio of energy gaps of semiconductors must be

(a) $\frac{E_A}{E_B} > 1$ (b) $\frac{E_A}{E_B} < 1$
(c) $E_A = E_B$ (d) E_A > 3eV and E_B < 1.5 eV

31. A p-n photodiode is made of a material with a band gap of 2eV . The minimum frequency of the radiation that can be absorbed by the material is nearly (take hc = 1240 eV – nm)

(a) $1 \times 10^{14} Hz$ (b) $20 \times 10^{14} Hz$
(c) $10 \times 10^{14} Hz$ (d) $5 \times 10^{14} Hz$

32. In active state of a transistor , the emitter base junction acts as a … A .. resistance and base - collector junction acts like a … B .. resistance. Here , A and B refer to

(a) low , low (b) low , high
(c) high , low (c) high , high

33. In an n-p-n transistor in CE configuration , when V_{CE} is increased , then

(a) I_B increases and I_C increases proportionally
(b) I_B increases and I_C remains constant
(c) Effect on I_B is negligible but I_C increases
(d) Both I_B and I_C remain nearly constant

34. In a common - emitter (CE) amplifier having a voltage gain G the transistor used has trans conductance 0.03 mho and current gain 25. If the above transistor is replaced with another one with transconductance 0.02 mho and current gain 20, the voltage gain will be

(a) $\frac{2}{3}G$ (b) 1.5 G (c) $\frac{1}{3}G$ (d) $\frac{5}{4}G$

35. An n-p –n transistor is connected in common - emitter configraction in a given amplifier . A load resistance of 800 Ω is connected in the collector circuit and the voltage drop across it is 0.8 V . If the current amplification factor is 0.96 and the input resistance of the circuit is 192 Ω , the voltage gain and the power gain of the amplifier will respectively be

(a) 3.69 , 3.84 (b) 4,4
(c) 4,3.69 (d) 4,3.84

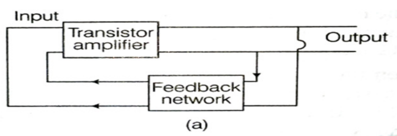
36. For an n p-n transistor used as amplifier , the power gain A_p is given by (A_V = voltage gain)

(a) $A_p = (\beta_{AC})^2 \times A_V$ (b) $A_p = \frac{1}{\beta_{AC}} A_V$
(c) $A_p = \beta_{AC} \times A_V$ (d) $A_p = \frac{1}{(\beta_{AC})^2} A_V$

37. For a CE transistor amplifier , the audio signal voltage across collector resistance of $2.0 k\Omega$ is 2.0 V . Suppose the current amplification factor of the transistor is 100. What should be the value of R_B in series with V_{BB} supply of 2.0 V , if DC base current has to be 10 times the signal current ? ($V_{BE} = 0.6\ V$)

(a) 14 $k\Omega$ (b) 24 $k\Omega$ (c) 34 $k\Omega$ (d) 44 $k\Omega$

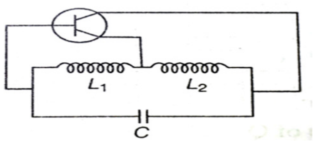
38. For tuned collector oscillator , using an n-p-n transistor from rise fall (or built up) of I_C, I_E current graphs . It can be concluded



(a) Both I_C, I_E increases initially

(b) Both I_C, I_E decrease but I_E decreases
(c) Initially I_C increases but I_E decreases
(d) Initially I_C increases but I_E increases

39. For the given circuit,

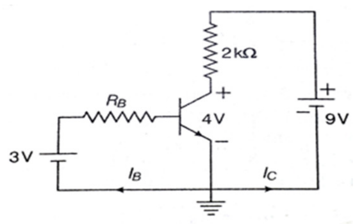


Frequency of oscillation is

(a) $f = \frac{1}{2\pi}\sqrt{\frac{1}{(L_1 + L_2)C}}$ (b) $f = \frac{1}{2\pi\sqrt{(L_1 - L_2)C}}$

(c) $f = \frac{1}{2\pi\sqrt{L_1 L_2 . C}}$ (d) $f = \frac{1}{2\pi\sqrt{\left(\frac{L_1 + L_2}{2}\right)C}}$

40. For the given circuit , if current amplification factor $\beta = 90$ and $V_{BE} = 0.7\ V$



Then , base resistance R_B is

(a) 180 $k\Omega$ (b) 185 $k\Omega$

(c) 82 $k\Omega$ (d) 190 $k\Omega$

41. The input signal given to a CE amplifier having a voltage gain of 150 is $V_i = 2\cos\left(15\,t + \frac{\pi}{3}\right)$. the corresponding output signal will be

(a) $300\cos\left(15\,t + \frac{\pi}{3}\right)$ (b) $75\cos\left(15\,t + \frac{2\pi}{3}\right)$

(c) $2\cos\left(15\,t + \frac{5\pi}{3}\right)$ (d) $300\cos\left(15\,t + \frac{4\pi}{3}\right)$

42. A transistor has a current gain of 30. If the collector resistance is 6 $k\Omega$, input resistance is 1 $k\Omega$, its voltage gain is

(a) 90 (b) 180 (c) 45 (d) 360

43. The input resistance of a transistor is 1000 Ω on charginging its base current by 10 μA , the collector current increases by 2mA . If a load resistance of 5 $k\Omega$ is used the circuit , the voltage gain of the amplifier is

(a) 100 (b) 500 (c) 1000 (d) 1500

44. In an n-p-n circuit transistor , the collector current is 10 mA . If 80 % electrons emitted reach the collector , then

(a) the emitter current will be 7.5 mA

(b) the base current will be 2.5 mA

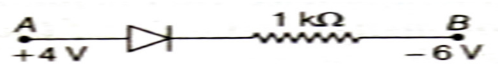
(c) the base current will be 3.5 mA

(d) the emitter current will be 15 mA

45. When the voltage drop across a p-n junction diode is increased from 0.65 V to 0.70 V , then change in the diode current is 5 mA . The dynamic resistance of the diode is

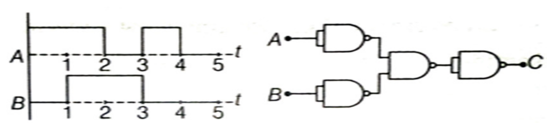
(a) 20 Ω (b) 50 Ω (c) 10 Ω (d) 80 Ω

46. Consider the junction diode as ideal . the value of current following through AB is

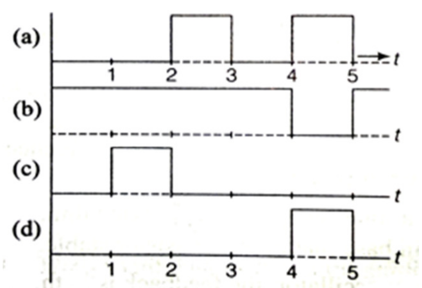


(a) $10^{-2}A$ (b) $10^{-1}A$ (c) $10^{-3}A$ (d) $0A$

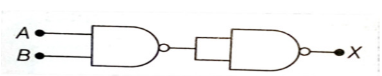
47. Input A and B are given to show combination of gates



Then , output C is



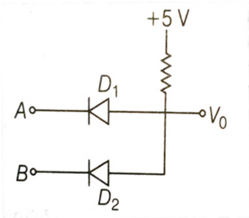
48. The output (X) of the logic circuit shown in figure will be



(a) $X = \bar{\bar{A}}.\bar{\bar{B}}$ (b) $X = \overline{A.B}$

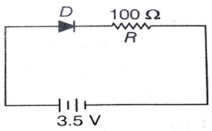
(c) $X = A.B$ (d) $X = \overline{A + B}$

49. See the circuit shown in the figure . Name the gate that the given circuit resembles



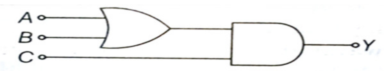
(a) $NAND$ (b) AND (c) OR (d) NOR

50. In the given figure , a diode D is connected to an external resistance to an external resistance R = 100 Ω and an emf of 3.5 V . If the barrier potential developed across the diode is 0.5V , the current in the circuit will be



(a) 30 mA (b) 40 mA (c) 20 mA (d) mA

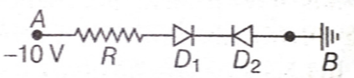
51. To get output 1 for the following circuit , the correct choice for the input is



(a) $A = 1 , B = 0 , C = 0$ (b) $A = 1 , B = 1 , C = 0$

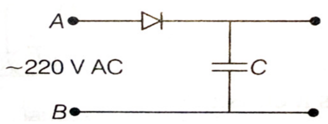
(c) $A = 1 , B = 0 , C =1$ (d) $A = 0 , B = 1 , C =0$

52. Assuming diodes to be ideal ,



(a) D_1 is forward biased and D_2 is reverse biased , so current flows from A to B
(b) D_2 is in forward bias and D_1 is in reverse biase and hence no current flows from B to A vice - versa
(c) D_1 and D_2 both are in forward bas , so current flows from A to B
(d) D_1 and D_2 both are in reverse bias , so no current flows from A to B

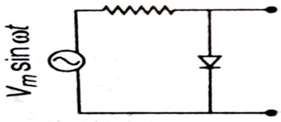
53. A 220 VAC supply is connected between points A and B



What will be potential difference across capacitor C?

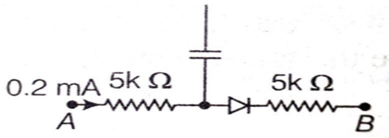
(a) 220 V (b) 110 V (c) 0 V (d) 220 $\sqrt{2}V$

54. Output of the circuit shown below will be



(a) Zero all the times
(b) Like half wave rectifier with positive cycles in output
(c) Like half wave rectifier with negative cycles in output
(d) Like that of a full wave rectifier

55. In the circuit shown , the voltage difference between A and B the diode forward voltage drop is 0.3 V



(a) 1.3 V (b) 2.3 V (c) 0 (d) 0.5 V

Hints and Explanations

1. (b)

2. (c)

3. (d)

4. (d)

5. (b)
For visible region , $450 \leq \lambda \leq 750$ nm
Photon energy range from few 1.7 to 2.8 eV .
$\left(hc = 1240\ eV - nm , E = \frac{hc}{\lambda}\right)$
As for silicon most of the photons have a higher energy , so they excite electrons (electron absorb photon) hence , light cannot pass through silicon . Silicon is opaque .
But as photons are not absorbed in ZnS , they pass through it and so Zinc sulphide is transparent .

6. (c)

7. (a)

8. (d)
Relation is found empirically it is , n $\propto T^{3/2}$.

9. (d)
Dopant concentration is usually
1 to 10 ppm (parts per million)
$\Rightarrow \frac{1}{10^7} \approx 10^{-7}$

10. (c)
Number if Si atoms 5× 10^{28} $atoms$ / m^3
Number of indium atoms = number of indium atoms for 1 silicon atom × Total number of Si atoms
= $\frac{5 \times 10^{28}}{5 \times 10^7}$ = 1× 10^{21} $atoms$ / m^3
= 1 × 10^{15} $atoms$ / cm^3

11. (b)
$n_h \times n_h = n_i^2$
$n_i = 2 \times 10^{16} m^{-3}$
$n_i = 4.5 \times 10^{22} m^{-3}$
$\therefore \quad n_e = \frac{n_i^2}{n_h} = \frac{(2 \times 10^{16})^2}{4.5 \times 10^{22}}$
$n_e = 8.89 \times 10^9 m^{-3}$

12. (c)

13. (d)

14. (c)
$\left|\frac{dV}{dr}\right|$ = E

V = Ed

Or $E = \frac{V}{d} = \frac{0.6\,V}{1 \times 10^{-6} m} = 6 \times 10^5 V\, m^{-1}$

15. (b)

16. (a)

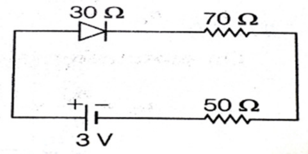
17. (b)

18. (a)
Diode is in reverse bias , current = 0 , potential difference across R = 0 ; V_{AB} = 6V

19. (a)

20. (b)
Dynamic resistance is $r_d = \frac{\Delta V}{\Delta I}$
$\Delta V = 0.7\,V - 0.65\,V = 0.05\,V$
$\Delta I = 5\,mA = 5 \times 10^{-3} A$
$\therefore \quad r_d = \frac{0.05}{5 \times 10^{-3}} = 10\,\Omega$

21. (c)
In the circuit , the upper diode D_i is reverse biased and lower diode D_2 is forward biased . Thus , there will be no current across upper diode function . The effective circuit will be shown as total resistance ,



R = 50 + 30 + 70 = 150 Ω
Current in circuit , $I = \frac{V}{R} = \frac{3V}{150\,\Omega} = 0.02\,A$

22. (d)

23. (c)

24. (d)

25. (c)

26. (c)

27. (c)

28. (b)

29. (c)
$\because \quad E_g = \frac{hc}{\lambda} = \frac{1240\, eV{-}nm}{620\, nm}$ =2.0 eV

30. (b)
In red LED , $\lambda_R = \frac{hc}{E_R}$
In violet , LED $\lambda_V = \frac{hc}{E_V} \Longrightarrow \quad \frac{E_R}{E_V} = \frac{\lambda_V}{\lambda_R} < 1$

31. (d)
E_g = 2eV
Wavelength of radiation corresponding to this energy
$\lambda = \frac{hc}{E_g} = \frac{1240\, eV{-}nm}{2\, eV}$ = 620 nm
$v = \frac{c}{\lambda} = \frac{3 \times 10^8 ms^{-1}}{620 \times 10^{-9} m} = 5 \times 10^{14}\, Hz$

32. (b)

33. (c)

34. (a)
$A_V = \beta \frac{R_L}{R_i} \qquad \left(\therefore\ g_m = \frac{\Delta I_c}{\Delta V} = \frac{\Delta I_c}{\Delta I_B R_i}\right)$
$or \qquad G = \left(\frac{\beta}{R_i}\right) R_L \qquad \left(\therefore\ g_m = \frac{\beta}{R_i}\right)$

$\Longrightarrow \quad G = g_m R_L \quad \Longrightarrow \quad G \propto g_m$

∴ $\frac{G_2}{G_1} = \frac{g_{m1}}{g_{m2}} \implies G_2 = \frac{0.02}{0.03} \times G$

∴ Voltage gain, $G_2 = \frac{2}{3}$ G

35. (d)
Resistance across load , R_L = 800 Ω
Voltage drop across load , V_L = 0.8 V
Input resistance of circuit, R_i = 192 Ω
Collector current is given by

$$I_C = \frac{V_L}{R_L} = \frac{0.8}{800} = \frac{8}{8000} = 1\text{mA}$$

∵ Current amplification

$$= \frac{Output\ current}{Input\ current} = \frac{I_C}{I_B} = 0.96$$

$\implies I_B = \frac{1\ mA}{0.96}$

∵ Voltage gain,

$A_V = \frac{V_L}{V_{in}} = \frac{V_L}{I_B R_i} = \frac{0.8 \times 0.96}{10^{-3} \times 192} = 4 \implies A_V = 4$

power gain ,

$A_p = \frac{I_C^2 R_L}{I_B^2 R_i} = \left(\frac{I_C}{I_B}\right)^2 . \frac{R_L}{R_i} = (0.96)^2 \times \frac{800}{192}$

A_p = 3.84

36. (c)
Power gain, $A_p = \beta_{AC} \times A_v$

37. (a)
The output AC voltage is 2.0 V . So , the AC collector current , i_C = 2.0 / 2000 = 1.0 mA . The signal current through the base is , therefore given by $i_B = \frac{i_C}{\beta} = \frac{1.0\ mA}{100}$ = 0.010 mA.
The DC base current has to be 10 × 0.010
= 0.10 mA.

$V_{BB} = V_{BE} + I_B R_B \implies R_B = (V_{BB} - V_{BE})\ /I_B$

Assuming V_{BE}= 0.6 V

R_B = (2.0 – 0.6) / 0.10 = 14 Ω

38. (a)

39. (a)
Inductors are in series ,
∴ $L_{eq} = L_1 + L_2$

And frequency of oscillator $= \frac{1}{2\pi}\sqrt{\frac{1}{L_{eq}\, C_{eq}}}$
$= \frac{1}{2\pi\sqrt{(L_1 + L_2)C}}$

40. (c)
Kirchhoff's loop rule in output loop,
9 - 4 $= I_C R_C$
R_C = 2 $k\Omega$

$\implies I_C = \frac{5}{2 \times 10^3}$ = 2.5 mA $\implies I_B = \frac{I_C}{\beta}$

$= \frac{2.5}{90} = 27.8\ \mu A$

V_{BE} = 0.7 V

$I_B\, R_B$ = 3 – 0.7 $\implies R_B = \frac{2.3}{27.8} \times 10^6 = 82\ k\Omega$

41. (d)
Input signal of a CE amplifier ,
$V_i = 2\cos\left(15t + \frac{\pi}{3}\right)$

Voltage gain , A_V = 150
As CE amplifier gives phase difference of π between input and output signals .

$A_V = \frac{V_o}{V_i}$

$\implies V_o = A_V V_i$

$V_o = 150 \times 2\cos\left(15\, t + \frac{\pi}{3} + \pi\right)$

$V = 300\cos\left(15\, t + \frac{4\,\pi}{3}\right)$

42. (b)
Voltage gain = current gain × Resistance gain
= current gain × $\frac{R_C}{R_I}$ = 30 × $\frac{6}{1}$ = 180

43. (c)
Current gain , $\beta = \left(\frac{\Delta I_C}{\Delta I_B}\right)_{V_{CE}}$

Voltage gain $A_V = \frac{\beta \times R_{out}}{R_{in}}$

R_{in} = 1000Ω , $\Delta I_B = 10\ \mu A = 10^{-5} A$

$R_{out} = 5\ k\Omega = 5 \times 10^3 \Omega$

ΔI_C = 2mA = $2 \times 10^{-3} A$

$\beta = \frac{2 \times 10^{-3}}{10^{-5}} = 200$

$A_V = \frac{200 \times 5 \times 10^3}{1000}$

44. (b)
I_C = 80 % of $I_E = \frac{80\, I_E}{100}$

or $I_E = \frac{I_C}{0.8} = \frac{10}{0.8}$ = 12.5 mA

$I_B = I_E - I_C$ = 12.5 – 10 = 2.5 mA

45. (c)
Dynamic resistance,

$r_d = \frac{\Delta V}{I\Delta} \implies r_d = \frac{0.05 \times 1000}{5}\ \Omega$ = 10 Ω

46. (a)
Let us assume that current through the diode is I . From the given condition ,