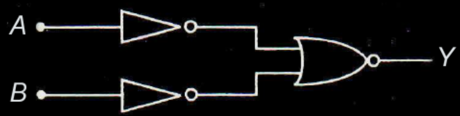
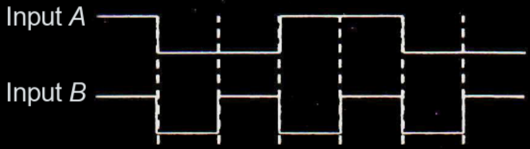
Chapter 27

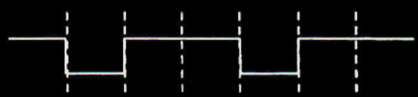
Semiconductor Electronics : Materials Devices and Simple Circuits

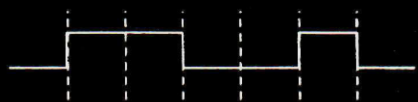
1. The logic circuit shown below has the input waveforms '*A*' and '*B*' as shown. Pick out the correct output waveform. **[AIEEE-2009]**

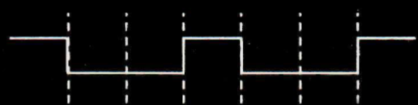


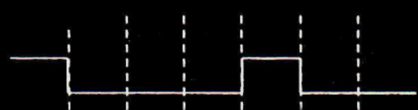


Output is :

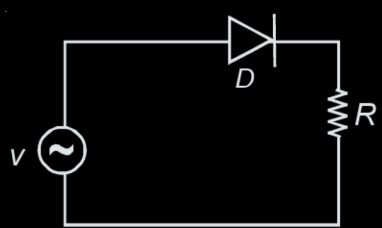
(1) 

(2) 

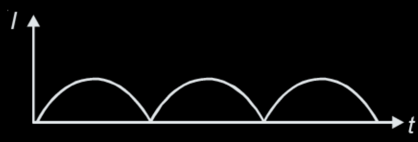
(3) 

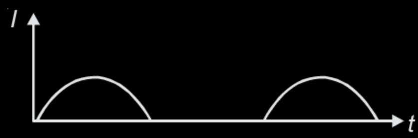
(4) 

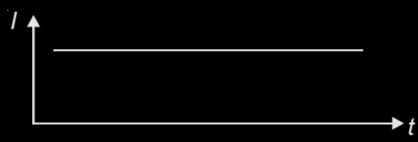
2. A *p-n* junction (*D*) shown in the figure can act as a rectifier. An alternating current source (*V*) is connected in the circuit. **[AIEEE-2009]**

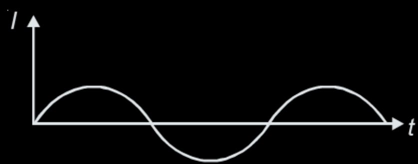


The current (*I*) in the resistor (*R*) can be shown by:

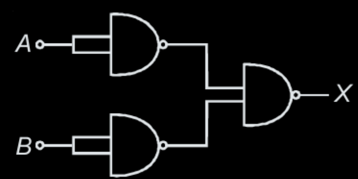
(1) 

(2) 

(3) 

(4) 

3. The combination of gates shown below yields **[AIEEE-2010]**

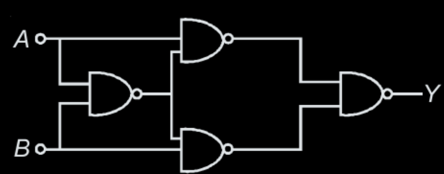


(1) NAND gate (2) OR gate
(3) NOT gate (4) XOR gate

4. The output of an OR gate is connected to both the inputs of a NAND gate. The combination will serve as a **[AIEEE-2011]**

(1) AND gate (2) OR gate
(3) NOT gate (4) NOR gate

5. Truth table for system of four NAND gates as shown in figure is **[AIEEE-2012]**



(1)

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

(2)

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

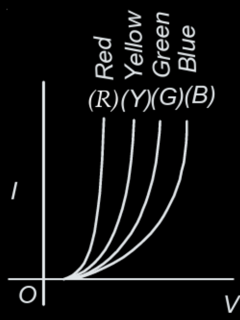
(3)

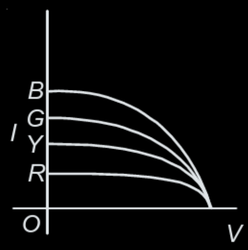
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

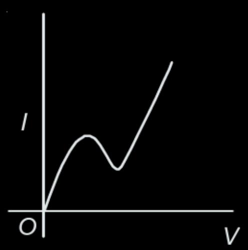
(4)

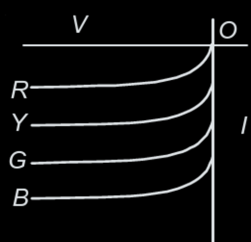
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

6. The *I* - *V* characteristic of an *LED* is **[JEE (Main)-2013]**

(1) 

(2) 

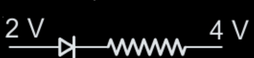
(3) 

(4) 

7. The forward biased diode connection is **[JEE (Main)-2014]**

(1) 

(2) 

(3) 

(4) 

8. The temperature dependence of resistances of Cu and undoped Si in the temperature range 300-400 K, is best described by **[JEE (Main)-2016]**

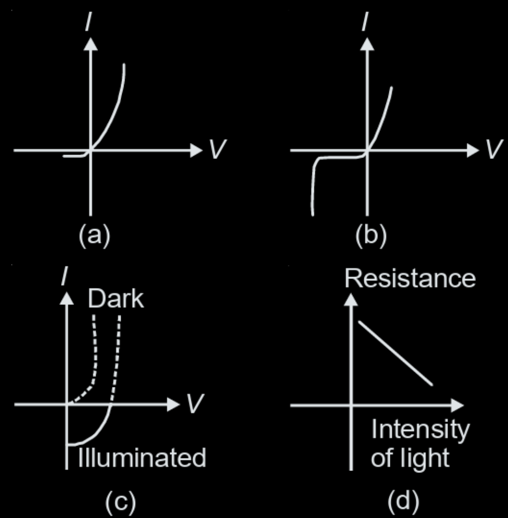
(1) Linear increase for Cu, exponential increase for Si

(2) Linear increase for Cu, exponential decrease for Si

(3) Linear decrease for Cu, linear decrease for Si

(4) Linear increase for Cu, linear increase for Si

9. Identify the semiconductor devices whose characteristics are given below, in the order (a), (b), (c), (d) : **[JEE (Main)-2016]**



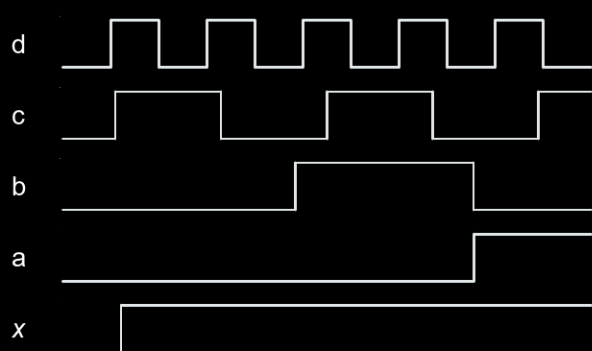
(1) Zener diode, Simple diode, Light dependent resistance, Solar cell

(2) Solar cell, Light dependent resistance, Zener diode, Simple diode

(3) Zener diode, Solar cell, Simple diode, Light dependent resistance

(4) Simple diode, Zener diode, Solar cell, Light dependent resistance

10. If a, b, c, d are inputs to a gate and *x* is its output, then, as per the following time graph, the gate is: **[JEE (Main)-2016]**



(1) AND (2) OR

(3) NAND (4) NOT

11. For a common emitter configuration, if α and β have their usual meanings, the incorrect relationship between α and β is : **[JEE (Main)-2016]**

(1) $\alpha = \dfrac{\beta}{1-\beta}$ (2) $\alpha = \dfrac{\beta}{1+\beta}$

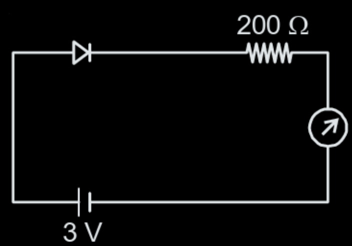
(3) $\alpha = \dfrac{\beta^2}{1+\beta^2}$ (4) $\dfrac{1}{\alpha} = \dfrac{1}{\beta} + 1$

12. In a common emitter amplifier circuit using an n-p-n transistor, the phase difference between the input and the output voltages will be **[JEE (Main)-2017]**

(1) 45° (2) 90°

(3) 135° (4) 180°

13. The reading of the ammeter for a silicon diode in the given circuit is **[JEE (Main)-2018]**



(1) 0 (2) 15 mA

(3) 11.5 mA (4) 13.5 mA

14. Mobility of electrons in a semiconductor is defined as the ratio of their drift velocity to the applied electric field. If, for an *n*-type semiconductor, the density of electrons is 10^{19} m^{-3} and their mobility is 1.6 $m^2/(V.s)$ then the resistivity of the semiconductor (since it is an *n*-type semiconductor contribution of holes is ignored) is close **[JEE (Main)-2019]**

(1) 2 Ωm (2) 0.2 Ωm

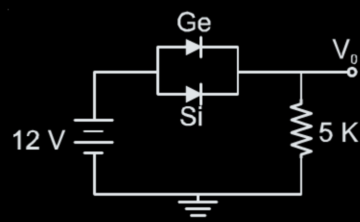
(3) 0.4 Ωm (4) 4 Ωm

15. Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross section 5 mm^2, is v. If the electron density in copper is $9 \times 10^{28}/m^3$ the value of v in mm/s is close to (Take charge of electron to be = 1.6×10^{-19} C) **[JEE (Main)-2019]**

(1) 0.02 (2) 0.2

(3) 3 (4) 2

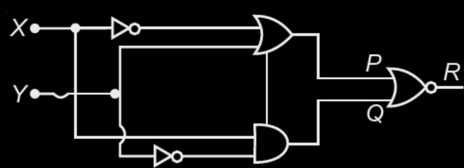
16. Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of V_0 changes by (assume that the Ge diode has large breakdown voltage) **[JEE (Main)-2019]**



(1) 0.2 V (2) 0.4 V

(3) 0.6 V (4) 0.8 V

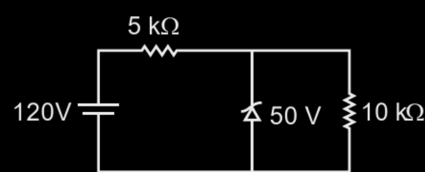
17. To get output '1' at *R*, for the given logic gate circuit the input values must be **[JEE (Main)-2019]**



(1) X = 1, Y = 1 (2) X = 0, Y = 0

(3) X = 1, Y = 0 (4) X = 0, Y = 1

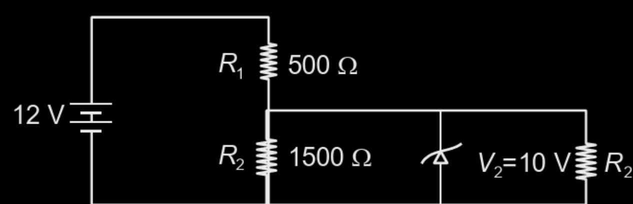
18. For the circuit shown below, the current through the Zener diode is **[JEE (Main)-2019]**



(1) Zero (2) 9 mA

(3) 14 mA (4) 5 mA

19. In the given circuit the current through Zener Diode is close to **[JEE (Main)-2019]**

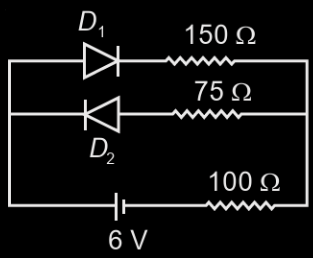


(1) 6.7 mA (2) 0.0 mA

(3) 4.0 mA (4) 6.0 mA

20. The circuit shown below contains two ideal diodes, each with a forward resistance of 50 Ω. If the battery voltage is 6 V, the current through the 100 Ω resistance (in amperes) is

[JEE (Main)-2019]

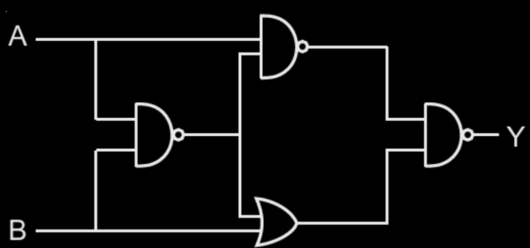


(1) 0.036 (2) 0.020

(3) 0.030 (4) 0.027

21. The output of the given logic circuit is

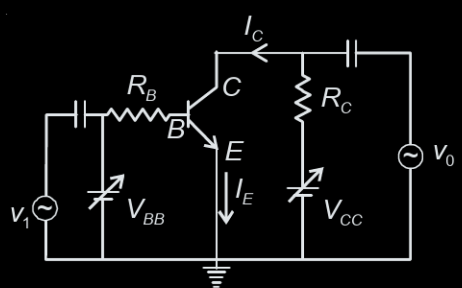
[JEE (Main)-2019]



(1) $A\overline{B}+\overline{A}B$ (2) $A\overline{B}$

(3) $AB+\overline{AB}$ (4) $\overline{A}B$

22.



In the figure, given that V_{BB} supply can vary from 0 to 5.0 V, V_{CC} = 5 V, β_{dc} = 200, R_B = 100 kΩ, R_C = 1 kΩ and V_{BE} = 1.0 V. The minimum base current and the input voltage at which the transistor will go to saturation, will be respectively

[JEE (Main)-2019]

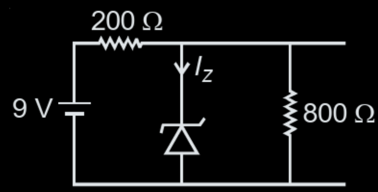
(1) 25 μA and 3.5 V

(2) 20 μA and 2.8 V

(3) 25 μA and 2.8 V

(4) 20 μA and 3.5 V

23. The reverse breakdown voltage of a Zener diode is 5.6 V in the given circuit. **[JEE (Main)-2019]**

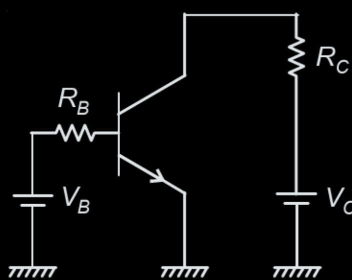


The current I_Z through the Zener is

(1) 15 mA (2) 7 mA

(3) 10 mA (4) 17 mA

24. A common emitter amplifier circuit, built using an npn transistor, is shown in the figure. Its dc current gain is 250, R_C = 1 kΩ and V_{CC} = 10 V. What is the minimum base current for V_{CE} to reach saturation? **[JEE (Main)-2019]**



(1) 10 μA (2) 100 μA

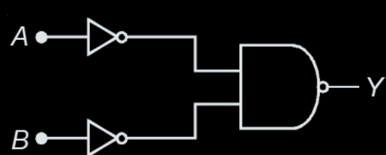
(3) 7 μA (4) 40 μA

25. An NPN transistor is used in common emitter configuration as an amplifier with 1 kΩ load resistance. Signal voltage of 10 mV is applied across the base-emitter. This produces a 3 mA change in the collector current and 15 μA change in the base current of the amplifier. The input resistance and voltage gain are **[JEE (Main)-2019]**

(1) 0.33 kΩ, 1.5 (2) 0.33 kΩ, 300

(3) 0.67 kΩ, 200 (4) 0.67 kΩ, 300

26. The logic gate equivalent to the given logic circuit is **[JEE (Main)-2019]**



(1) OR (2) NAND

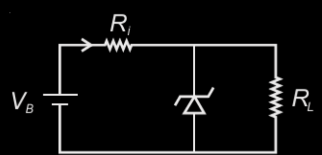
(3) AND (4) NOR

27. An npn transistor operates as a common emitter amplifier, with a power gain of 60 dB. The input circuit resistance is 100 Ω and the output load resistance is 10 kΩ. The common emitter current gain β is : **[JEE (Main)-2019]**

(1) 10^4 (2) 6×10^2

(3) 10^2 (4) 60

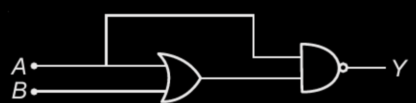
28. The figure represents a voltage regulator circuit using a Zener diode. The breakdown voltage of the Zener diode is 6 V and the load resistance is, R_L = 4 kΩ. The series resistance of the circuit is R_i = 1 kΩ. If the battery voltage V_B varies from 8 V to 16 V, what are the minimum and maximum values of the current through Zener diode? **[JEE (Main)-2019]**



(1) 0.5 mA; 6 mA (2) 0.5 mA; 8.5 mA

(3) 1.5 mA; 8.5 mA (4) 1 mA; 8.5 mA

29. The truth table for the circuit given in the fig. is: **[JEE (Main)-2019]**



(1)

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

(2)

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

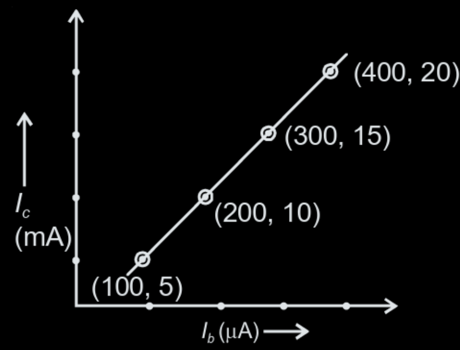
(3)

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

(4)

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

30. The transfer characteristic curve of a transistor, having input and output resistance 100 Ω and 100 kΩ respectively, is shown in the figure. The Voltage and Power gain, are respectively : **[JEE (Main)-2019]**



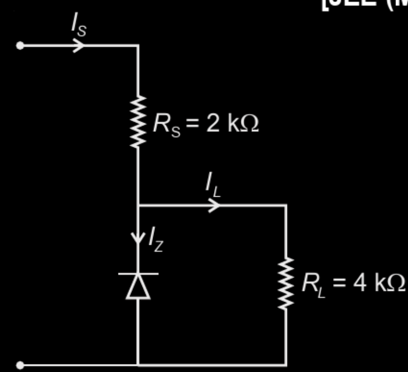
(1) 5×10^4, 2.5×10^6

(2) 2.5×10^4, 2.5×10^6

(3) 5×10^4, 5×10^6

(4) 5×10^4, 5×10^5

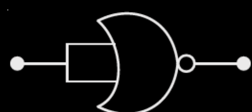
31. Figure shows a *DC* voltage regulator circuit, with a Zener diode of breakdown voltage = 6 V. If the unregulated input voltage varies between 10 V to 16 V, then what is the maximum Zener current? **[JEE (Main)-2019]**

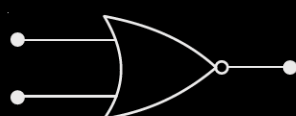


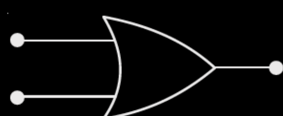
(1) 7.5 mA (2) 1.5 mA

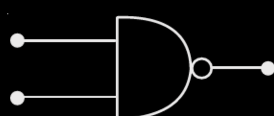
(3) 2.5 mA (4) 3.5 mA

32. Which of the following gives a reversible operation? **[JEE (Main)-2020]**

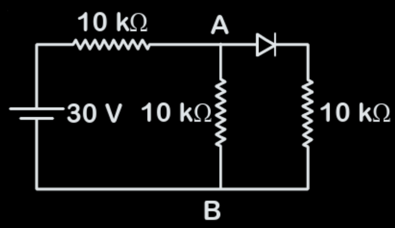
(1) 

(2) 

(3) 

(4) 

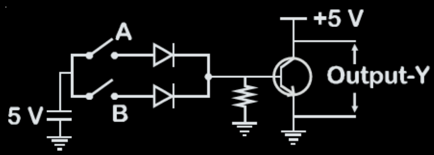
33. In the figure, potential difference between A and B is **[JEE (Main)-2020]**



(1) Zero (2) 5 V

(3) 10 V (4) 15 V

34. Boolean relation at the output stage-Y for the following circuit is **[JEE (Main)-2020]**

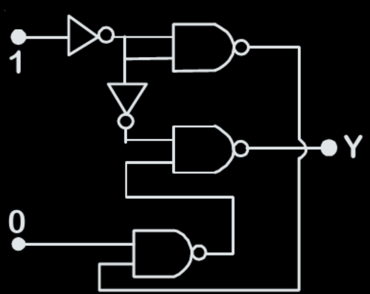


(1) $\bar{A}\cdot\bar{B}$ (2) $A \cdot B$

(3) $A + B$ (4) $\bar{A}+\bar{B}$

35. In the given circuit, value of Y is

[JEE (Main)-2020]



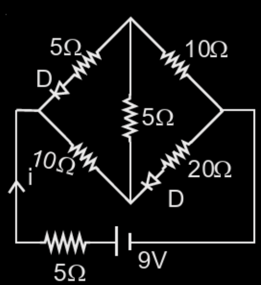
(1) Toggles between 0 and 1

(2) 0

(3) 1

(4) Will not execute

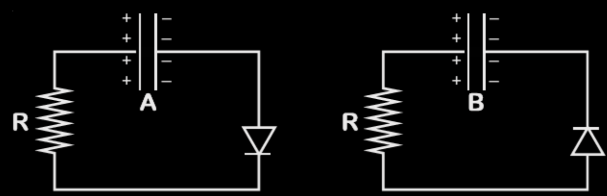
36. The current i in the network is **[JEE (Main)-2020]**



(1) 0.3 A (2) 0.6 A

(3) 0 A (4) 0.2 A

37. Two identical capacitors A and B, charged to the same potential 5 V are connected in two different circuits as shown below at time $t = 0$. If the charge on capacitors A and B at time $t = CR$ is Q_A and Q_B respectively, then (Here e is the base of natural logarithm) **[JEE (Main)-2020]**



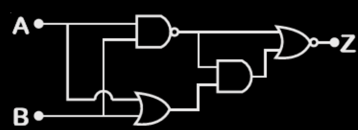
(1) $Q_A = \frac{CV}{2}, Q_B = \frac{VC}{e}$

(2) $Q_A = VC, Q_B = CV$

(3) $Q_A = \frac{CV}{e}, Q_B = \frac{VC}{2}$

(4) $Q_A = VC, Q_B = \frac{VC}{e}$

38. In the following digital circuit, what will be the output at 'Z', when the input (A, B) are (1, 0), (0, 0), (1, 1,), (0, 1) **[JEE (Main)-2020]**



(1) 1, 1, 0, 1 (2) 0, 0, 1, 0

(3) 1, 0, 1, 1 (4) 0, 1, 0, 0

39. When a diode is forward biased, it has a voltage drop of 0.5 V. The safe limit of current through the diode is 10 mA. If a battery of emf 1.5 V is used in the circuit, the value of minimum resistance to be connected in series with the diode so that the current does not exceed the safe limit is

[JEE (Main)-2020]

(1) 50 Ω (2) 200 Ω

(3) 300 Ω (4) 100 Ω

40. If a semiconductor photodiode can detect a photon with a maximum wavelength of 400 nm, then its band gap energy is **[JEE (Main)-2020]**

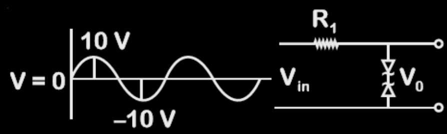
Planck's constant $h = 6.63 \times 10^{-34}$ J.s.

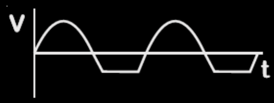
Speed of light $c = 3 \times 10^8$ m/s

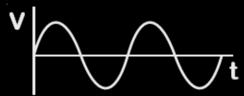
(1) 1.1 eV (2) 2.0 eV

(3) 3.1 eV (4) 1.5 eV

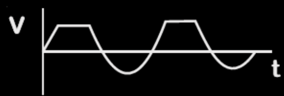
41. Take the breakdown voltage of the zener diode used in the given circuit as 6 V. For the input voltage shown in figure below, the time variation of the output voltage is (Graphs drawn are schematic and not to scale) **[JEE (Main)-2020]**



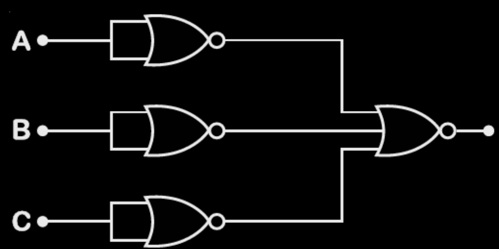
(1) 

(2) 

(3) 

(4) 

42. Identify the operation performed by the circuit given below. **[JEE (Main)-2020]**



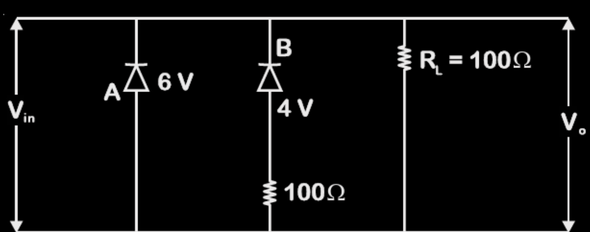
(1) AND (2) NOT

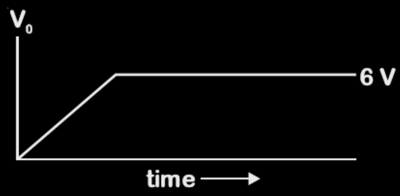
(3) NAND (4) OR

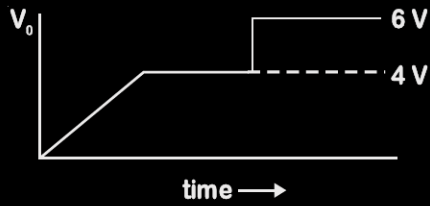
43. Two Zener diodes (A and B) having breakdown voltages of 6 V and 4 V respectively, are connected as shown in the circuit below. The output voltage V_0 variation with input voltage linearly increasing with time, is given by

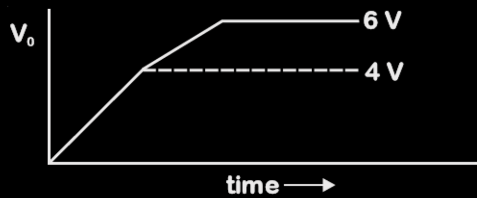
(V_{input} = 0 V at t = 0)

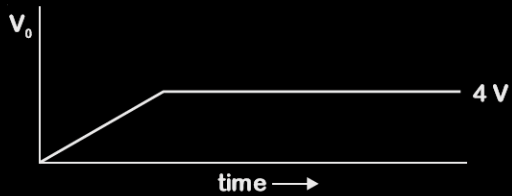
(figures are qualitative) **[JEE (Main)-2020]**



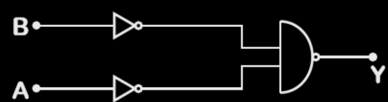
(1) 

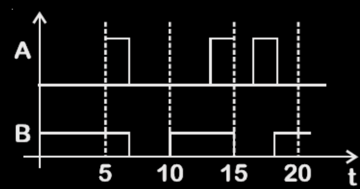
(2) 

(3) 

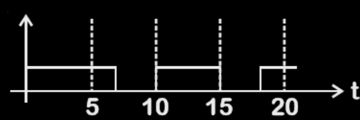
(4) 

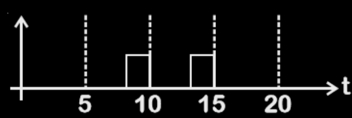
44. Identify the correct output signal Y in the given combination of gates (as shown) for the given inputs A and B. **[JEE (Main)-2020]**





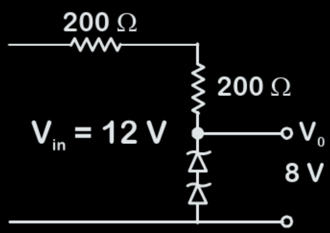
(1) 

(2) 

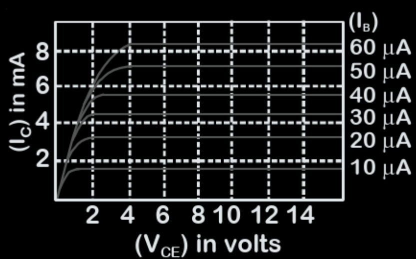
(3) 

(4) 

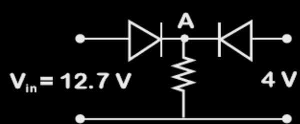
45. The circuit shown below is working as a 8 V dc regulated voltage source. When 12 V is used as input, the power dissipated (in mW) in each diode is; (considering both zener diodes are identical) ______. **[JEE (Main)-2020]**



46. The output characteristics of a transistor is shown in the figure. When V_{CE} is 10 V and I_C = 4.0 mA, then value of β_{ac} is ______. **[JEE (Main)-2020]**



47. Both the diodes used in the circuit shown are assumed to be ideal and have negligible resistance when these are forward biased. Built in potential in each diode is 0.7 V. For the input voltages shown in the figure, the voltage (in Volts) at point *A* is ______ **[JEE (Main)-2020]**



48. If an emitter current is changed by 4 mA, the collector current changes by 3.5 mA. The value of β will be: **[JEE (Main)-2021]**

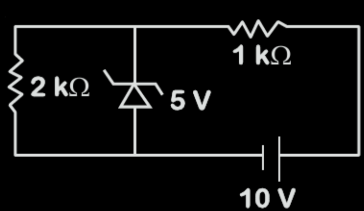
(1) 7

(2) 0.5

(3) 0.875

(4) 3.5

49. In connection with the circuit drawn below, the value of current flowing through 2 kΩ resistor is ______ × 10^{-4} A. **[JEE (Main)-2021]**



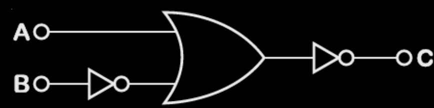
50. Zener breakdown occurs in a p-n junction having p and n both **[JEE (Main)-2021]**

(1) Lightly doped and have narrow depletion layer

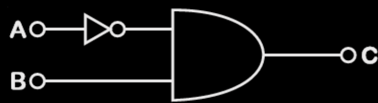
(2) Heavily doped and have narrow depletion layer

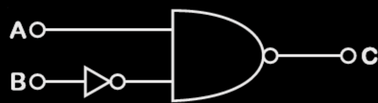
(3) Heavily doped and have wide depletion layer

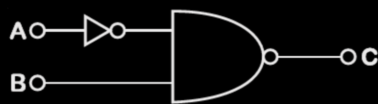
(4) Lightly doped and have wide depletion layer

51. 

The logic circuit shown above is equivalent to **[JEE (Main)-2021]**

(1) 

(2) 

(3) 

(4) 

52. Given below are two statements :

Statement I : PN junction diodes can be used to function as transistor, simply by connecting two diodes, back to back, which acts as the base terminal.

Statement II : In the study of transistor, the amplification factor β indicates ratio of the collector current to the base current.

In the light of the above statements, choose the correct answer from the options given below. **[JEE (Main)-2021]**

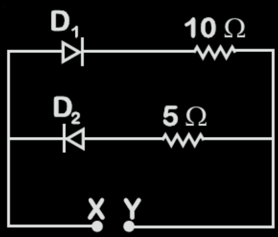
(1) Both Statement I and Statement II are false

(2) Statement I is true but Statement II is false

(3) Statement I is false but Statement II is true

(4) Both statement I and Statement II are true

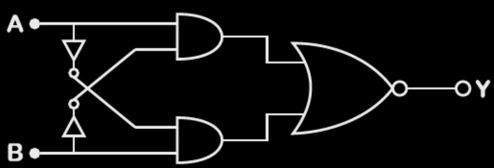
53. A 5 V battery is connected across the points X and Y. Assume D_1 and D_2 to be normal silicon diodes. Find the current supplied by the battery if the +ve terminal of the battery is connected to point X. **[JEE (Main)-2021]**



(1) ~ 1.5 A (2) ~ 0.5 A

(3) ~ 0.43 A (4) ~ 0.86 A

54. The truth table for the following logic circuit is **[JEE (Main)-2021]**



(1)

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

(2)

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

(3)

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

(4)

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

55. Match List I with List II.

List I	List II
(a) Rectifier	(i) Used either for stepping up or stepping down the a.c. voltage
(b) Stabilizer	(ii) Used to convert a.c. voltage into d.c. voltage
(c) Transformer	(iii) Used to remove any ripple in the rectified output voltage
(d) Filter	(iv) Used for constant output voltage even when the input voltage or load current change

Choose the correct answer from the options given below : **[JEE (Main)-2021]**

(1) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)

(2) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

(3) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

(4) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

56. For extrinsic semiconductors; when doping level is increased; **[JEE (Main)-2021]**

(1) Fermi-level of p-type semiconductors will go downward and Fermi-level of n-type semiconductor will go upward.

(2) Fermi-level of p and n-type semiconductors will not be affected.

(3) Fermi-level of both p-type and n-type semiconductors will go upward for $T > T_F$ K and downward for $T < T_F$ K, where T_F is Fermi temperature.

(4) Fermi-level of p-type semiconductor will go upward and Fermi-level of n-type semiconductors will go downward.

57. LED is constructed from Ga-As-P semiconducting material. The energy gap of this LED is 1.9 eV. Calculate the wavelength of light emitted and its colour. **[JEE (Main)-2021]**

[$h = 6.63 \times 10^{-34}$ Js and $c = 3 \times 10^{8}$ ms^{-1}]

(1) 654 nm and red colour

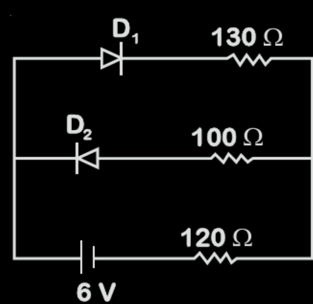
(2) 1046 nm and blue colour

(3) 1046 nm and red colour

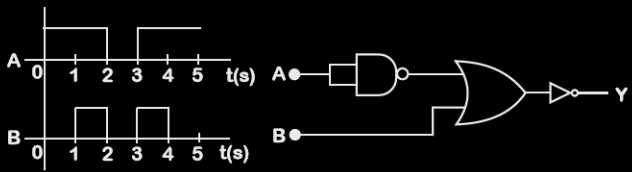
(4) 654 nm and orange colour

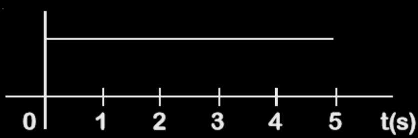
58. The circuit contains two diodes each with a forward resistance of 50 Ω and with infinite reverse resistance. If the battery voltage is 6 V, the current through the 120 Ω resistance is __________ mA.

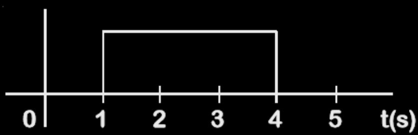
[JEE (Main)-2021]

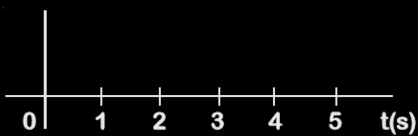


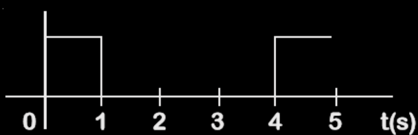
59. Draw the output signal Y in the given combination of gates. **[JEE (Main)-2021]**



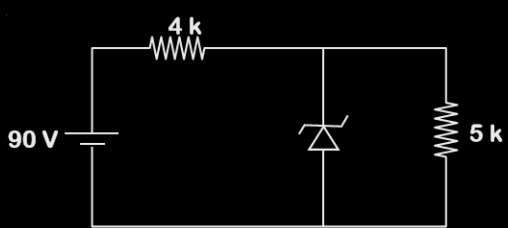
(1)


(2)


(3)


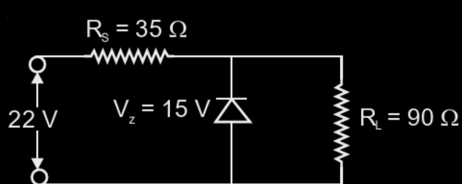
(4)


60. The zener diode has a V_z = 30 V. The current passing through the diode for the following circuit is _______mA. **[JEE (Main)-2021]**



61. The value of power dissipated across the zener diode (V_z = 15 V) connected in the circuit as shown in the figure is x × 10^{-1} watt

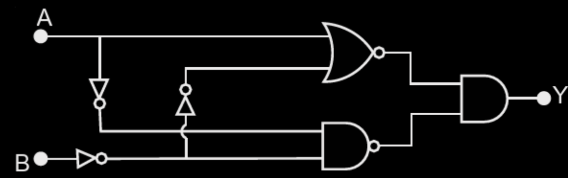
[JEE (Main)-2021]



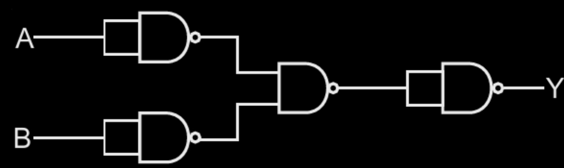
The value of x, to the nearest integer, is _____

62. In the logic circuit shown in the figure, if input A and B are 0 and 1 respectively, the output at Y would be 'x'. **[JEE (Main)-2021]**

The value of x is______.



63. The following logic gate is equivalent to: **[JEE (Main)-2021]**



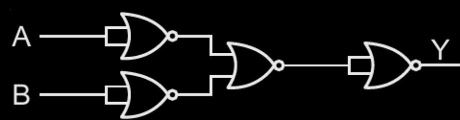
(1) OR Gate

(2) NAND Gate

(3) NOR Gate

(4) AND Gate

64. The output of the given combination gates represents: **[JEE (Main)-2021]**



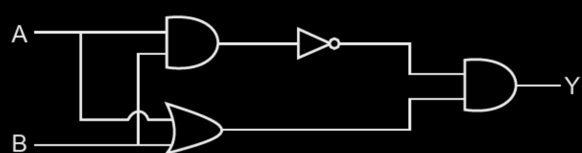
(1) AND Gate

(2) NOR Gate

(3) NAND Gate

(4) XOR Gate

65. Which one of the following will be the output of the given circuit? **[JEE (Main)-2021]**



(1) NAND Gate (2) XOR Gate

(3) NOR Gate (4) AND Gate

66. An npn transistor operates as a common emitter amplifier with a power gain of 10^6. The input circuit resistance is 100 Ω and the output load resistance is 10 kΩ. The common emitter current gain 'β' will be _______. (Round off to the Nearest Integer)

[JEE (Main)-2021]

67. The correct relation between α (ratio of collector current to emitter current) and β (ratio of collector current to base current) of a transistor is:

[JEE (Main)-2021]

(1) $\alpha = \frac{\beta}{1+\beta}$

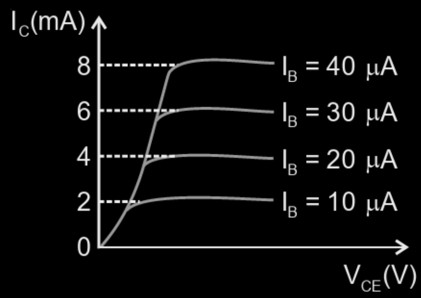
(2) $\alpha = \frac{\beta}{1-\alpha}$

(3) $\beta = \frac{1}{1-\alpha}$

(4) $\beta = \frac{\alpha}{1+\alpha}$

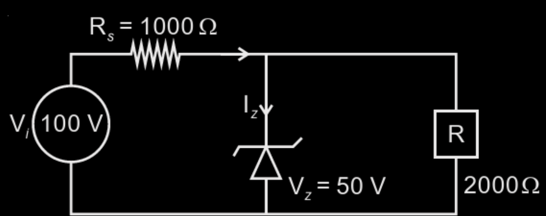
68. The typical output characteristics curve for a transistor working in the common-emitter configuration is shown in the figure.

[JEE (Main)-2021]



The estimated current gain from the figure is ______.

69. For the circuit shown below, calculate the value of I_z: **[JEE (Main)-2021]**



(1) 0.1 A

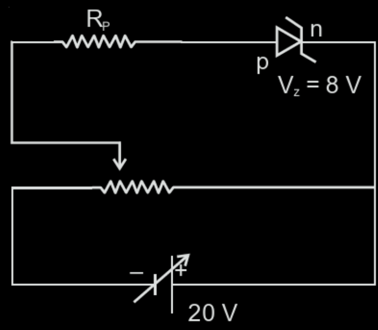
(2) 25 mA

(3) 0.05 A

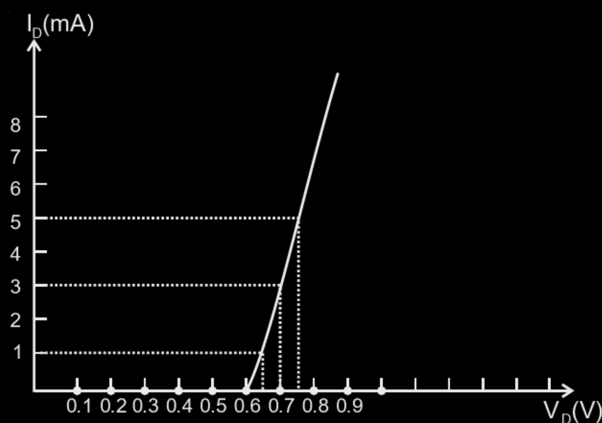
(4) 0.15 A

70. A zener diode having zener voltage 8 V and power dissipation rating of 0.5 W is connected across a potential divider arranged with maximum potential drop across zener diode as shown in the diagram. The value of protective resistance R_P is ______ Ω.

[JEE (Main)-2021]



71. For the forward biased diode characteristics shown in the figure, the dynamic resistance at I_D = 3 mA will be ______ Ω. **[JEE (Main)-2021]**



72. Consider a situation in which reverse biased current of a particular P-N junction increases when it is exposed to a light of wavelength $\leq$ 621 nm. During this process, enhancement in carrier concentration takes place due to generation of hole-electron pairs. The value of band gap is nearly.

[JEE (Main)-2021]

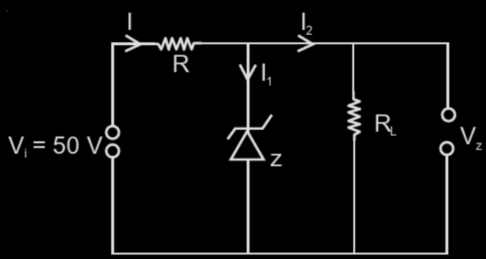
(1) 1 eV

(2) 4 eV

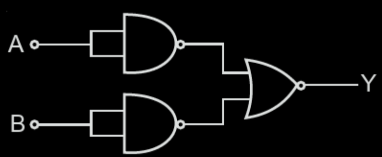
(3) 0.5 eV

(4) 2 eV

73. In a given circuit diagram, a 5 V zener diode along with a series resistance is connected across a 50 V power supply. The minimum value of the resistance required, if the maximum zener current is 90 mA will be ______ Ω. **[JEE (Main)-2021]**



74. Identify the logic operation carried out. **[JEE (Main)-2021]**



(1) NAND

(2) NOR

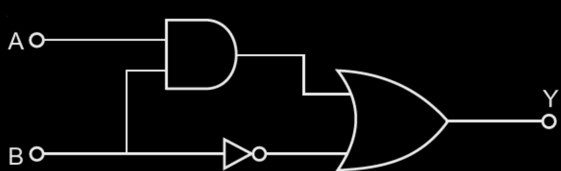
(3) OR

(4) AND

75. In a semiconductor, the number density of intrinsic charge carriers at 27°C is $1.5 \times 10^{16}/m^3$. If the semiconductor is doped with impurity atom, the hole density increases to $4.5 \times 10^{22}/m^3$. The electron density in the doped semiconductor is ________ $\times 10^9/m^3$. **[JEE (Main)-2021]**

76. A transistor is connected in common emitter circuit configuration, the collector supply voltage is 10 V and the voltage drop across a resistor of 1000 Ω in the collector circuit is 0.6 V. If the current gain factor (β) is 24, then the base current is ______ μA. (Round off to the Nearest Integer) **[JEE (Main)-2021]**

77. Find the truth table for the function Y of A and B represented in the following figure **[JEE (Main)-2021]**



(1)

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

(2)

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

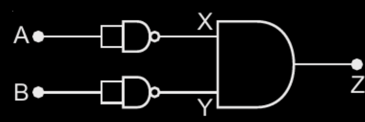
(3)

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

(4)

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

78. Identify the logic operation carried out by the given circuit: **[JEE (Main)-2021]**



(1) NOR

(2) AND

(3) OR

(4) NAND

79. **Statement I:**

By doping silicon semiconductor with pentavalent material, the electron density increases.

Statement II:

The n-type semiconductor has net negative charge.

In the light of the above statements, choose the **most appropriate** answer from the options given below: **[JEE (Main)-2021]**

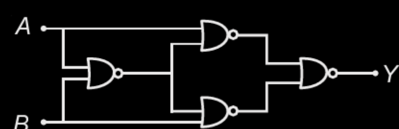
(1) Both statement I and statement II are true

(2) Both statement I and statement II are false

(3) Statement I is true but statement II is false

(4) Statement I is false but statement II is true

80. Four NOR gates are connected as shown in figure. The truth table for the given figure is: **[JEE (Main)-2021]**



(1)

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

(2)

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

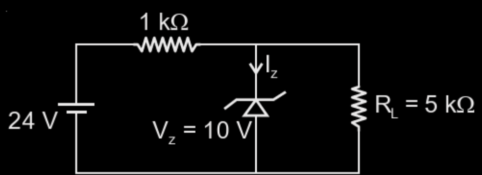
(3)

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

(4)

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

81. For the given circuit, the power across zener diode is _______mW. **[JEE (Main)-2021]**



82. For a transistor in CE mode to be used as an amplifier, it must be operated in:

[JEE (Main)-2021]

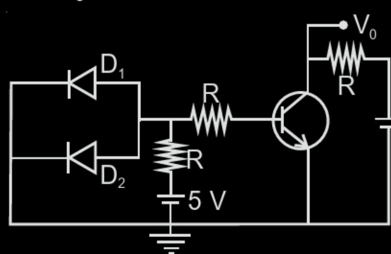
(1) Cut-off region only

(2) Saturation region only

(3) Both cut-off and saturation

(4) The active region only

83. A circuit is arranged as shown in figure. The output voltage V_0 is equal to ____ V. **[JEE (Main)-2021]**



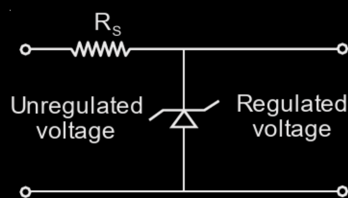
84. For a transistor α and β are given as $\alpha = \frac{I_C}{I_E}$ and $\beta = \frac{I_C}{I_B}$. Then the correct relation between α and β will be: **[JEE (Main)-2021]**

(1) $\alpha = \frac{1-\beta}{\beta}$ (2) $\beta = \frac{\alpha}{1-\alpha}$

(3) $\alpha\beta = 1$ (4) $\alpha = \frac{\beta}{1-\beta}$

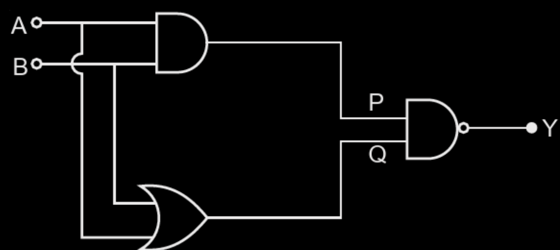
85. A zener diode of power rating 2 W is to be used as a voltage regulator. If the zener diode has a breakdown of 10 V and it has to regulate voltage fluctuated between 6 V and 14 V, the value of R_S for safe operation should be _____ Ω.

[JEE (Main)-2021]



86. In the following logic circuit the sequence of the inputs A, B are (0, 0), (0, 1), (1, 0) and (1, 1). The output Y for this sequence will be:

[JEE (Main)-2021]



(1) 0, 1, 0, 1

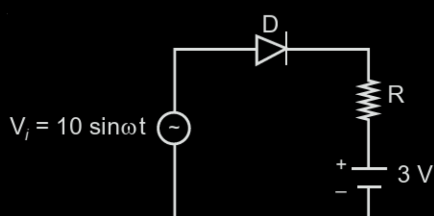
(2) 0, 0, 1, 1

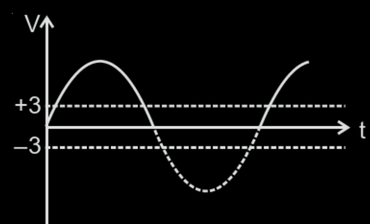
(3) 1, 0, 1, 0

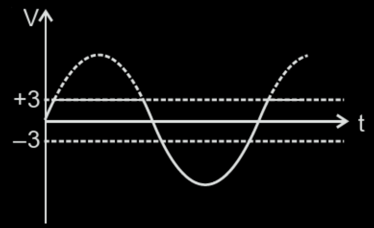
(4) 1, 1, 1, 0

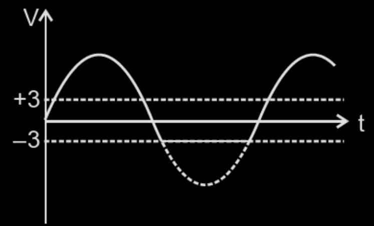
87. Choose the correct waveform that can represent the voltage across R of the following circuit, assuming the diode is ideal one:

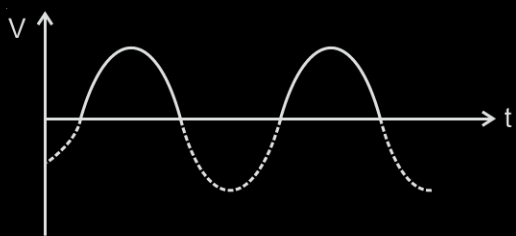
[JEE (Main)-2021]



(1) 

(2) 

(3) 

(4) 

88. **Statement I :**

To get a steady dc output from the pulsating voltage received from a full wave rectifier we can connect a capacitor across the output parallel to the load R_L.

Statement II :

To get a steady dc output from the pulsating voltage received from a full wave rectifier we can connect an inductor in series with R_L.

In the light of the above statements, choose the **most appropriate** answer from the options given below: **[JEE (Main)-2021]**

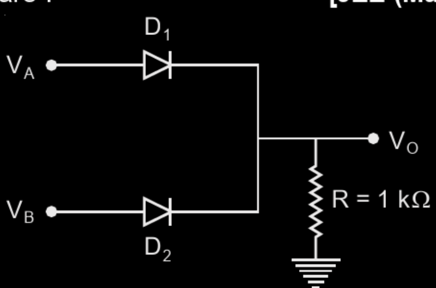
(1) Both statement I and statement II are true

(2) Statement I is false but statement II is true

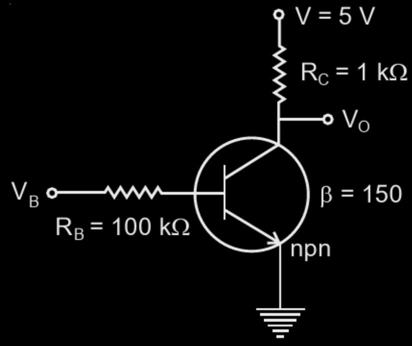
(3) Both statement I and statement II are false

(4) Statement I is true but statement II is false

89. If V_A and V_B are the input voltages (either 5 V or 0 V) and V_O is the output voltage then the two gates represented in the following circuits (A) and (B) are : **[JEE (Main)-2021]**



(A)



(B)

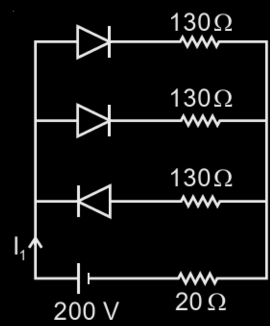
(1) NAND and NOR Gate

(2) AND and OR Gate

(3) OR and NOT Gate

(4) AND and NOT Gate

90. In the given figure, each diode has a forward bias resistance of 30 Ω and infinite resistance in reverse bias. The current I_1 will be: **[JEE (Main)-2021]**



(1) 2 A (2) 2.35 A

(3) 3.75 A (4) 2.73 A

91. A transistor is used in common-emitter mode in an amplifier circuit. When a signal of 10 mV is added to the base-emitter voltage, the base current changes by 10 μA and the collector current changes by 1.5 mA. The load resistance is 5 kΩ. The voltage gain of the transistor will be ____. **[JEE (Main)-2022]**

92. The photodiode is used to detect the optical signals. These diodes are preferably operated in reverse biased mode because : **[JEE (Main)-2022]**

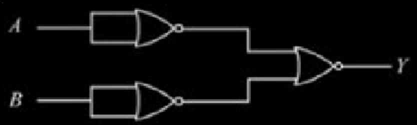
(1) fractional change in majority carriers produce higher forward bias current

(2) fractional change in majority carriers produce higher reverse bias current

(3) fractional change in minority carriers produce higher forward bias current

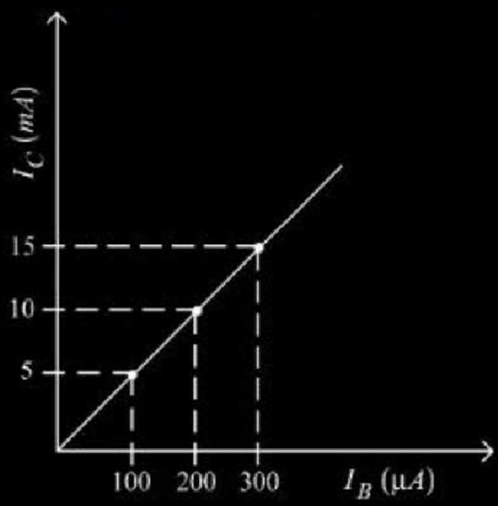
(4) fractional change in minority carriers produce higher reverse bias current

93. Identify the logic operation performed by the given circuit: [JEE (Main)-2022]



(1) AND gate (2) OR gate
(3) NOR gate (4) NAND gate

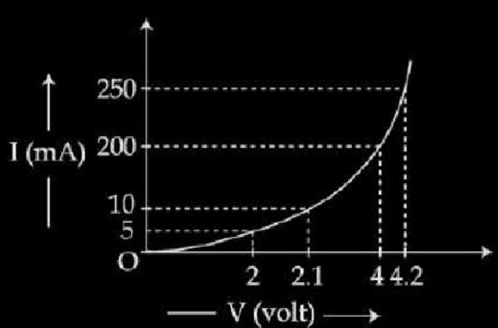
94. In an experiment of *CE* configuration of *n-p-n* transistor, the transfer characteristics are observed as given in figure. [JEE (Main)-2022]



If the input resistance is 200 Ω and output resistance is 60 Ω, the voltage gain in this experiment will be_________.

95. The *I-V* characteristics of a p-n junction diode in forward bias is shown in the figure. The ratio of dynamic resistance, corresponding to forward bias voltage of 2 V and 4 V respectively, is :

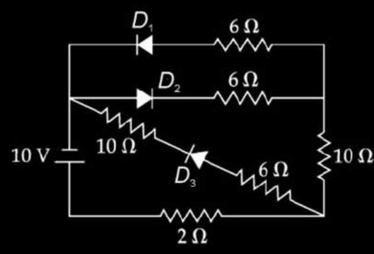
[JEE (Main)-2022]



(1) 1 : 2 (2) 5 : 1
(3) 1 : 40 (4) 20 : 1

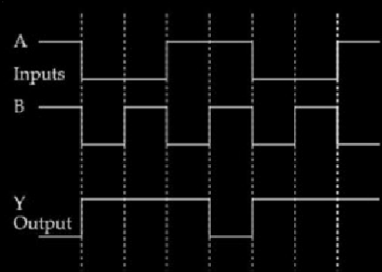
96. As per the given circuit, the value of current through the battery will be _______ A.

[JEE (Main)-2022]



97. Identify the correct Logic Gate for the following output (*Y*) of two inputs *A* and *B*.

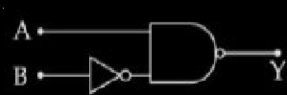
[JEE (Main)-2022]



(1) 

(2) 

(3) 

(4) 

98. For a transistor to act as a switch, it must be operated in [JEE (Main)-2022]

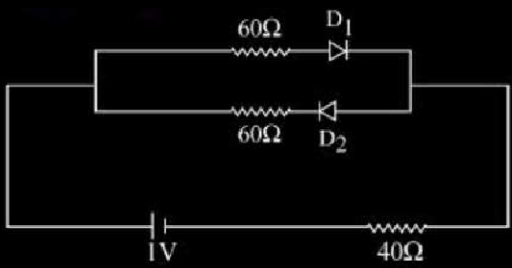
(1) Active region

(2) Saturation state only

(3) Cut-off state only

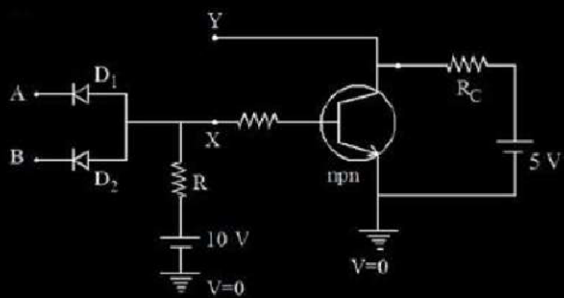
(4) Saturation and cut-off state

99. The cut-off voltage of the diodes (shown in figure) in forward bias is 0.6 V. The current through the resistor of 40 Ω is _____ mA. **[JEE (Main)-2022]**



100. In the following circuit, the correct relation between output (Y) and inputs A and B will be:

[JEE (Main)-2022]



(1) $Y = AB$
(2) $Y = A + B$
(3) $Y = \overline{AB}$
(4) $Y = \overline{A+B}$

101. For using a multimeter to identify diode from electrical components, choose the correct statement out of the following about the diode:

[JEE (Main)-2022]

(1) It is two terminal device which conducts current in both directions.

(2) It is two terminal device which conducts current in one direction only

(3) It does not conduct current gives an initial deflection which decays to zero.

(4) It is three terminal device which conducts current in one direction only between central terminal and either of the remaining two terminals.

102. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : n-p-n transistor permits more current than a p-n-p transistor.

Reason R: Electrons have greater mobility as a charge carrier.

Choose the correct answer from the options given below: **[JEE (Main)-2022]**

(1) Both **A** and **R** are true, and **R** is correct explanation of **A**.

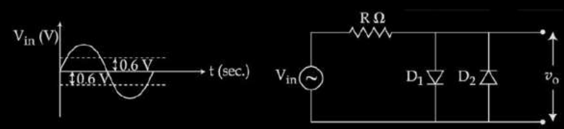
(2) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**.

(3) **A** is true but **R** is false.

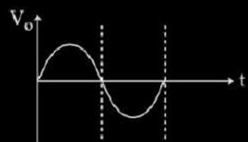
(4) **A** is false but **R** is true.

103. In the given circuit the input voltage V_{in} is shown in figure. The cut-in voltage of *p-n* junction diode (D_1 or D_2) is 0.6 V. Which of the following output voltage (V_0) waveform across the diode is correct?

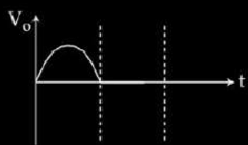
[JEE (Main)-2022]



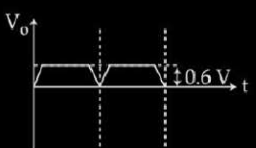
(1)



(2)

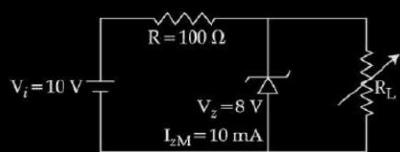


(3)



(4)

104. A zener of breakdown voltage V_Z = 8 V and maximum Zener current, I_{ZM} = 10 mA is subjected to an input voltage V_i = 10 V with series resistance R = 100 Ω. In the given circuit R_L represents the variable load resistance. The ratio of maximum and minimum value of R_L is _________. **[JEE (Main)-2022]**



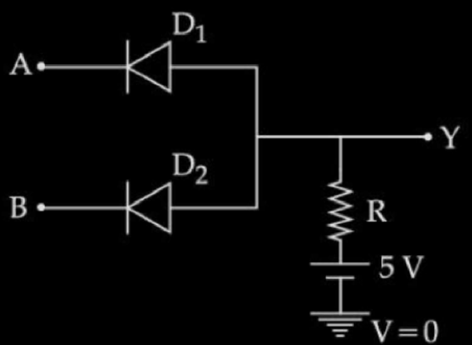
105. A transistor is used in an amplifier circuit in common emitter mode. If the base current changes by 100 μA, it brings a change of 10 mA in collector current. If the load resistance is 2 kΩ and input resistance is 1 kΩ, the value of power gain is $x \times 10^4$. The value of x is _______.

[JEE (Main)-2022]

106. A potential barrier of 0.4 V exists across a p-n junction. An electron enters the junction from the n-side with a speed of $6.0 \times 10^5\ ms^{-1}$. The speed with which electrons enters the p side will be $\frac{x}{3} \times 10^5\ ms^{-1}$ the value of x is _________.

(Give mass of electron = 9×10^{-31} kg, charge on electron = 1.6×10^{-19} C) **[JEE (Main)-2022]**

107. In the circuit, the logical value of $A = 1$ or $B = 1$ when potential at A or B is 5 V and the logical value of $A = 0$ or $B = 0$ when potential at A or B is 0 V. **[JEE (Main)-2022]**



The truth table of the given circuit will be:

(1)

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

(2)

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

(3)

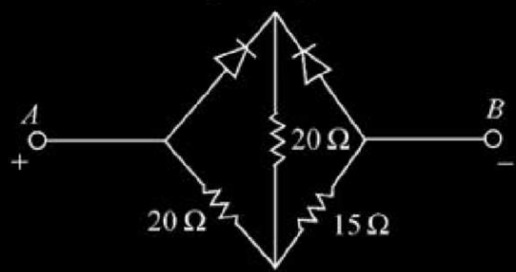
A	B	Y
0	0	0
1	0	0
0	1	0
1	1	0

(4)

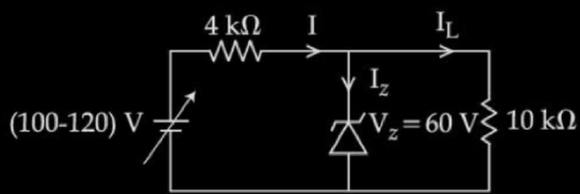
A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

108. The energy band gap of semiconducting material to produce violet (wavelength = 4000 Å) LED is _________ eV. (Round off to the nearest integer). **[JEE (Main)-2022]**

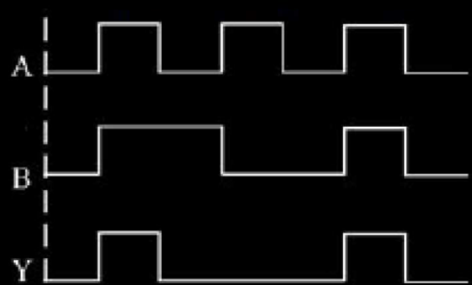
109. Two ideal diodes are connected in the network as shown is figure. The equivalent resistance between A and B is ____ Ω. **[JEE (Main)-2022]**



110. In the circuit shown below, maximum Zener diode current will be ________ mA. **[JEE (Main)-2022]**



111. A logic gate circuit has two inputs A and B and output Y. The voltage waveforms of A, B and Y are shown below. **[JEE (Main)-2022]**



The logic gate circuit is :

(A) AND gate

(B) OR gate

(C) NOR gate

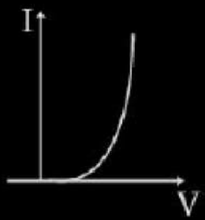
(D) NAND gate

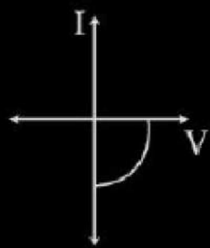
112. For a constant collector-emitter voltage of 8 V, the collector current of a transistor reached to the value of 6 mA from 4 mA, whereas base current changed from 20 μA to 25 μA value. If transistor is in active state, small signal current gain (current amplification factor) will be

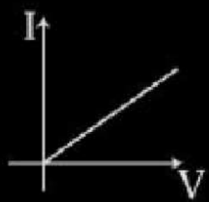
[JEE (Main)-2022]

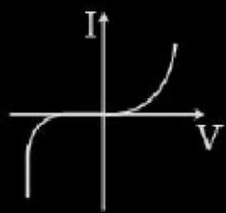
(1) 240 (2) 400
(3) 0.0025 (4) 200

113. Identify the solar cell characteristics from the following options : **[JEE (Main)-2022]**

(1)


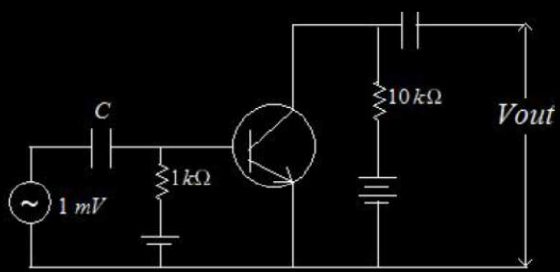
(2)


(3)


(4)


114. An n.p.n. transistor with current gain β = 100 in common emitter configuration is shown in figure. The output voltage of the amplifier will be

[JEE (Main)-2022]

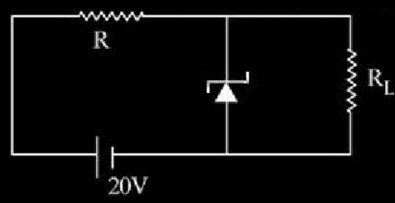


(1) 0.1 V (2) 1.0 V
(3) 10 V (4) 100 V

115. If the potential barrier across a *p-n* junction is 0.6 V. Then the electric field intensity, in the depletion region having the width of 6×10^{-6} m, will be ______ $\times 10^5$ N/C. **[JEE (Main)-2022]**

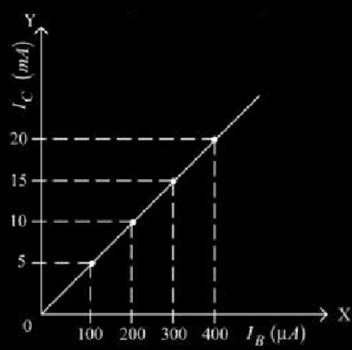
116. A 8 V Zener diode along with a series resistance *R* is connected across a 20 V supply (as shown in the figure). If the maximum Zener current is 25 mA, then the minimum value of *R* will be _____ Ω.

[JEE (Main)-2022]



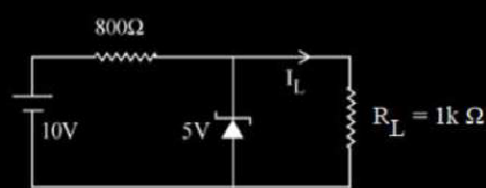
117. The typical transfer characteristics of a transistor in CE configuration is shown in figure. A load resistor of 2 kΩ is connected in the collector branch of the circuit used. The input resistance of the transistor is 0.50 kΩ. The voltage gain of the transistor is ________.

[JEE (Main)-2022]



118. In the given circuit, the value of current I_L will be __________ mA. (When R_L = 1 kΩ)

[JEE (Main)-2022]



Chapter 27

Semiconductor Electronics : Materials Devices and Simple Circuits

1. Answer (4)

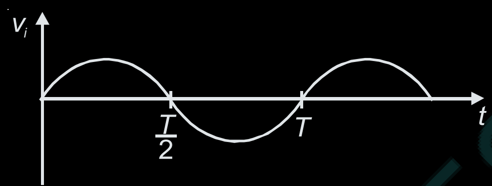
$$y = \left(\overline{\overline{A}+\overline{B}}\right) = A \,.\, B$$

The combination represents AND Gate Truth table.

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

2. Answer (2)

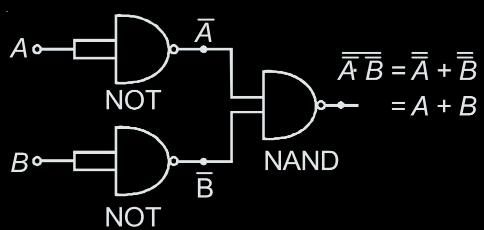
Let input be



From $0-\frac{T}{2}$ Diode is in forward bias so there will be current

From $\frac{T}{2}-T$ Diodes is in reverse bias so current through resistor will be zero.

3. Answer (2)



4. Answer (4)

The output is

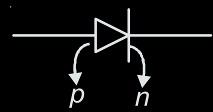
$$y = \overline{(A+B)}$$

5. Answer (4)

6. Answer (1)

The LED emitting red colour will have a smaller energy gap between conduction band and valance band. Accordingly its knee voltage would be less.

7. Answer (1)



For forward Bias, p-side must be at higher potential than n-side.

8. Answer (2)

For metals, resistance increases upon increase in temperature. For undoped Si, resistance decreases upon decrease in temperature.

9. Answer (4)

Information based question.

10. Answer (2)

OR gate as output is 1 when any of the input is 1.

11. Answer (1, 3)

$$I_e = I_b + I_c$$

$$\frac{I_e}{I_c} = \frac{I_b}{I_c} + 1$$

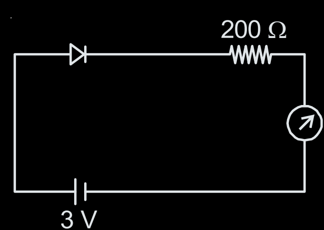
$$\frac{1}{\alpha} = \frac{1}{\beta} + 1$$

or $\alpha = \dfrac{\beta}{1+\beta}$

12. Answer (4)

In common emitter configuration for n-p-n transistor, phase difference between output and input voltage is 180°.

13. Answer (3)



$$I = \frac{V - V_{\text{diode}}}{R}$$

$$= \left[\frac{3 - 0.7}{200} \times 1000\right] \text{ mA}$$

$$= 11.5 \text{ mA}$$

14. Answer (3)

$I = n.e\,A\,\mu\,E$

$$I = \frac{n.eA\mu V}{L}$$

$$\frac{V}{I} = \frac{L}{n.eA\mu} = \rho\frac{L}{A}$$

$$\Rightarrow \rho = \frac{1}{ne\mu} = \frac{1}{10^{19} \times 1.6 \times 10^{-19} \times 1.6} = \frac{1}{2.56}$$

$\Rightarrow \rho = 0.4\ \Omega\text{m}$

15. Answer (1)

$\vec{J} = n\,e\,v_d$

$$\therefore \quad \frac{1.5}{5 \times 10^{-6}} = 9 \times 10^{28} \times 1.6 \times 10^{-19} \times v$$

$$\Rightarrow v = \frac{1.5}{(5 \times 9 \times 1.6 \times 10^{3})} = 2.08 \times 10^{-5} \text{m/s}$$

$\Rightarrow v = 0.02$ mm/s

16. Answer (2)

Voltage drop across diode will change from 0.3 to 0.7 V.

Value of V_0 changes by 0.4 V.

17. Answer (3)

$$A = \left[\overline{(\bar{x} + y) + \overline{x\bar{y}}}\right]$$

$$= \overline{\bar{x} + y + \bar{x} + y}$$

$$A = \overline{(\bar{x} + y)}$$

Output is 1 when $x = 1$, $y = 0$

18. Answer (2)

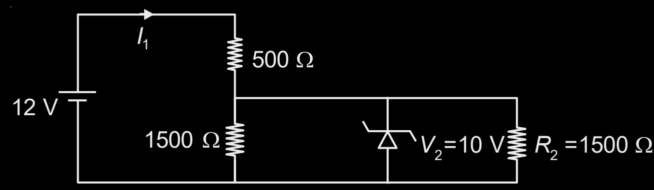
$$I_b = \frac{120 - 50}{5 \times 10^{3}} = \frac{70}{5} \times 10^{-3}$$

$\Rightarrow I_b = 14$ mA

and $I_L = \dfrac{50}{10 \times 10^{3}} = 5$ mA

$\therefore\ I_Z = 14 - 5 = 9$ mA

19. Answer (2)



$$(V_{R_2})_{\max} = \frac{12 \times 750}{1250}$$

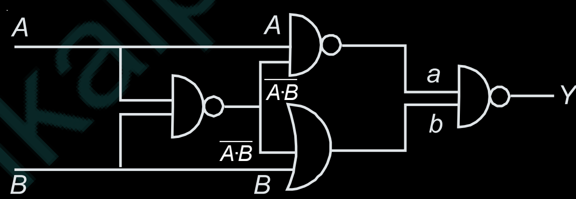
$(V_{R_2})_{\max} < V_Z$

So, current through Zener diode is zero.

20. Answer (2)

$$I = \frac{6}{50 + 150 + 100} = \frac{6}{300} \text{ A} = 0.02 \text{ A}$$

21. Answer (2)



$$a = \overline{A.A.B}$$

$$= \bar{A} + \overline{\overline{A.B}}$$

$$= \bar{A} + A.B$$

$$b = \overline{A.B} + B$$

$$= \bar{A} + \bar{B} + B = 1$$

$$Y = \overline{a.b} = \bar{a} + \bar{b}$$

$$\bar{a} = \overline{A + AB}$$

$$= \bar{\bar{A}} \cdot (\bar{A} + \bar{B})$$

$$= A\bar{A} + A\bar{B}$$

$$\bar{a} = A\bar{B}$$

$$\therefore Y = \bar{a} + \bar{b}$$

$$= \bar{a} + \bar{1}$$

$$= A\bar{B} + 0 = A\bar{B}$$

22. Answer (1)

$V_{CC} - I_C R_C = 0$

$V_{BB} - I_b R_b = V_{BE}$

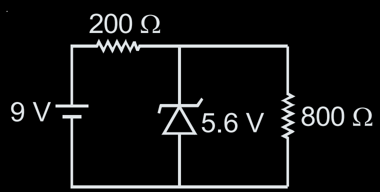
$I_C = 200\ I_b$

$I_C = 5\text{ mA},\ I_b = 25\ \mu\text{A}$

$V_{BB} - 25 \times 10^{-6} \times 100 \times 10^{3} = 1$

$V_{BB} = 3.5\text{ V}$

23. Answer (3)



$$I_{800\,\Omega} = \frac{5.6}{800}\text{ A} = 7\text{ mA}$$

$$I_{200\,\Omega} = \frac{9-5.6}{200} = 17\text{ mA}$$

$\therefore\ I_Z = 17 - 7 = 10\text{ mA}$

24. Answer (4)

For saturation, $V_{CC} - i_c \times R_c = 0$

$$\Rightarrow\ i_c = \frac{V_{CC}}{R_C} = \frac{10}{10^3} = 10^{-2}\text{ A}$$

$$\because\ \beta = \frac{I_C}{I_B} = 250$$

$$\therefore\ I_B = \frac{I_C}{250} = \frac{10^{-2}}{250} = 40\ \mu\text{A}$$

25. Answer (4)

$$\beta = \frac{I_C}{I_B} = 200$$

$$R_i = \frac{10\times 10^{-3}}{15\times 10^{-6}} = 0.67\text{ k}\Omega$$

$$\text{Voltage Gain} = \beta\left(\frac{R_o}{R_i}\right) = 300$$

26. Answer (1)

$y = \overline{\overline{A}\cdot\overline{B}} = A + B$

$y = A + B$

$\Rightarrow$ OR gate

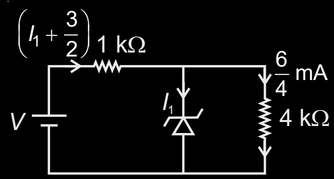
27. Answer (3)

$$P_{\text{gain}} = \beta^2\left(\frac{R_{\text{out}}}{R_{\text{in}}}\right)\ \&\ I_{\text{gain}} = \beta$$

$$\therefore\ 10^6 = \beta^2\left(\frac{10000}{100}\right)$$

$\beta = 100$

28. Answer (2)



$$I_1 = \left(8 - 6 - \frac{3}{2}\right) = \frac{1}{2} = 0.5\text{ mA}$$

$$I_2 = \left(16 - 6 - \frac{3}{2}\right) = 8.5\text{ mA}$$

29. Answer (4)

$\Rightarrow\ y = \overline{A\cdot(A+B)} = \overline{A} + \overline{(A+B)}$

$\Rightarrow\ y = \overline{A} + \overline{A}\cdot\overline{B} = \overline{A}\,(1+\overline{B})$

$\Rightarrow\ y = \overline{A}$

30. Answer (1)

$$\beta = \frac{I_c}{I_b}$$

$$= \frac{5\times 10^{-3}}{100\times 10^{-6}}$$

$= 50$

$$\text{Voltage gain} = \beta\frac{R_O}{R_i} = 5\times 10^4$$

Power gain = β (voltage gain)

$= 250 \times 10^4$

$= 2.5 \times 10^6$

31. Answer (4)

I_Z is maximum when input voltage is 16 V.

$$I_S = \frac{10}{2\times 10^3} = 5\text{ mA}$$

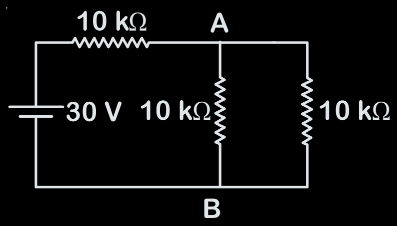
$$I_L = \frac{6}{4\times 10^3} = 1.5\text{ mA}$$

$I_{Z(\text{max})} = I_S - I_L = 3.5\text{ mA}$

32. Answer (1)

NOT gate is reversible gate because the input signal can be recovered.

33. Answer (3)

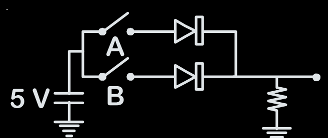


Here the diode is in forward bias. So we replace it by a connecting wire.

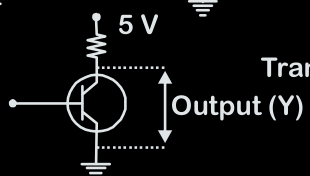
$$V_a - V_b = \frac{I}{2} \times 10$$

$$= \frac{30}{15 \times 2} \times 10 \text{ V} = 10 \text{ V}$$

34. Answer (1)



Diode OR Gate

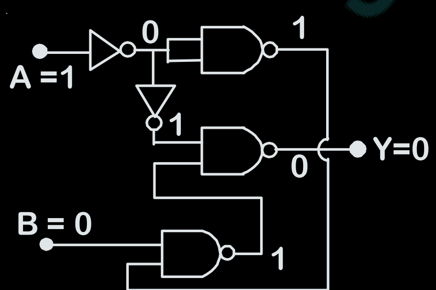


Transistor NOT Gate

$\therefore$ OR + NOT $\rightarrow$ NOR Gate

$$Y = \overline{A + B} = \overline{A} \cdot \overline{B}$$

35. Answer (2)



$$Y = \overline{\overline{AB}.A} = \overline{\overline{AB}} + \overline{A} = AB + \overline{A}$$

Y = 0 + 0 = 0

36. Answer (1)

Both the diodes are reverse biased

$$I = \frac{9}{30} = 0.3A$$

37. Answer (4)

In case I diode is reverse biased

$Q_A = CV$

n case II, current will flow as diode is forward biased.

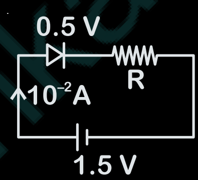
$$Q_B = \frac{CV}{e}$$

38. Answer (2)

Truth Table

A	B	$W = \overline{A.B}$	$X = A + B$	$Y = W.X$	$Z = \overline{W + Y}$
1	0	1	1	0	0
0	0	1	0	0	0
1	1	0	1	0	1
0	1	1	1	1	0

39. Answer (4)



$$R = \frac{V}{I}$$

$$= \frac{1}{10^{-2}} = 100\ \Omega$$

40. Answer (3)

For photodiode to detect $\frac{hc}{\lambda}$ > band gap energy

$\Rightarrow$ band gap energy $= \frac{hc}{\lambda_{max}}$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{400 \times 10^{-9}}$$

$$= 5 \times 10^{-19} \text{ J}$$

$$= 3.1 \text{ eV}$$

41. Answer (3)

Zener diode works in reverse bias and potential drop across it remains constant.

42. Answer (1)

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

$\Rightarrow$ AND gate

43. Answer (3)

Voltage across R_L increases up to 4 V, then one of the zener diode will blow. So, option (3) is correct.

44. Answer (2)

$$Y = \overline{\overline{A} \cdot \overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$$

Truth Table

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

45. Answer (40)

$$i = \frac{(12-8)}{400} = 10^{-2} \text{ A}$$

$P = 4 \times 10^{-2} = 40$ mW

46. Answer (150)

$$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B}$$

$$\Delta I_C = (4.5 - 3) \text{ mA}$$

$$\Delta I_n = (30 - 20)\ \mu A = 10\ \mu A$$

$$\beta_{ac} = \frac{1500}{10} = 150$$

47. Answer (12)

$V_A = 12.7 - 0.7 = 12$ Volt

Right hand diode will be reversed biased

48. Answer (1)

$$\Delta I_E = 4 \text{ mA}$$

$$\Delta I_C = 3.5 \text{ mA}$$

$$\Rightarrow \Delta I_B = (4 - 3.5) \text{ mA}$$

$$= 0.5 \text{ mA}$$

$$\therefore \beta = \frac{\Delta I_C}{\Delta I_B} = \frac{3.5}{0.5} = 7$$

49. Answer (25)

$$i = \frac{V_z}{R} = \frac{5}{2 \times 10^3}$$

$$= 25 \times 10^{-4} \text{ A}$$

50. Answer (2)

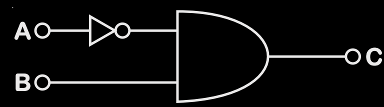
Zener diode has both p and n side highly doped and depletion layer is very thin.

51. Answer (1)

From gates diagram,

$$\overline{(A + \overline{B})} = \overline{A} \cdot \overline{\overline{B}} = \overline{A} \cdot B$$

$\Rightarrow$



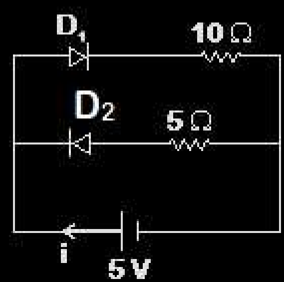
52. Answer (3)

Transistor is formed by formation of two p-n junctions by sandwiching a thin base layer. So, statement I is false.

$$\because \quad \beta = \frac{\Delta I_C}{\Delta I_B} \text{ and for DC, } \beta = \frac{I_C}{I_B}$$

So, statement II is true.

53. Answer (3)



$$i \sim \frac{(5-0.7)}{10}$$

$$\Rightarrow \quad i \sim 0.43 \text{ A}$$

54. Answer (3)

Truth table

A	B	$C = A \cdot \overline{B}$	$D = \overline{A} \cdot B$	$C + D$	$\overline{C+D} = Y$
0	0	0	0	0	1
0	1	0	1	1	0
1	0	1	0	1	0
1	1	0	0	0	1

55. Answer (2)

Correct match are

a → (ii)

b → (iv)

c → (i)

d → (iii)

56. Answer (1)

Fermi-level of p type semiconductor goes down whereas it goes up for n-type semiconductor.

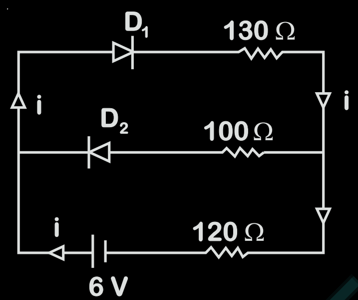
57. Answer (1)

$\Delta E_g = 1.9$ eV

$\therefore \quad \lambda = \dfrac{1242}{1.9}$ nm

= 654 nm of red colour

58. Answer (20)



$i = \dfrac{6}{50+130+120}$

$= \dfrac{6000}{300} \times 10^{-3}$ A

= 20 mA

59. Answer (4)

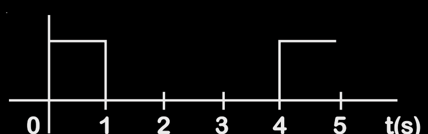
$A = 0 \Rightarrow Y = 0$ for $B = 0$ or $B = 1$

$A = 1 \Rightarrow Y = 0$ for $B = 1$

$A = 1 \Rightarrow Y = 1$ for $B = 0$

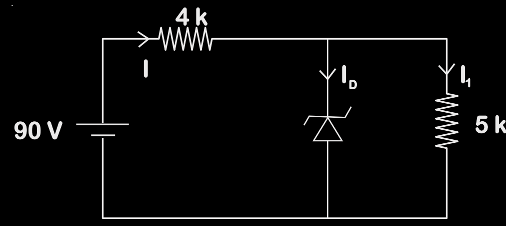
Hence output is 1 only when $A = 1$ and $B = 0$

⇒



60. Answer (09.00)

$I_1 = \dfrac{30}{5{,}000} \text{A} = 6 \text{ mA}$



also $-90 + 4000\,I + 30 = 0$

$\Rightarrow I = 15$ mA

$\Rightarrow I_D = 15 - 6 = 9$ mA

61. Answer (5)

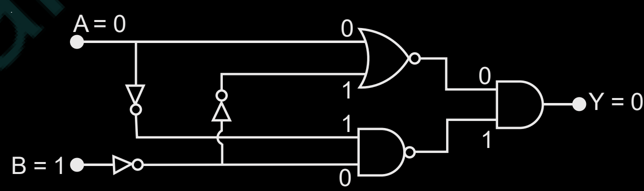
$P = V_Z I_Z$

$i = \dfrac{22-15}{35} = \dfrac{1}{5}\text{A}$ and $i' = \dfrac{15}{90} = \dfrac{1}{6}\text{A}$

$i_Z = \dfrac{1}{5} - \dfrac{1}{6} = \dfrac{1}{30}\text{A}$

$P = 15 \times \dfrac{1}{30} = 5 \times 10^{-1}$ W

62. Answer (0)



63. Answer (3)

$X = \overline{\overline{\overline{A}\,\overline{B}}}$

$X = \overline{A+B}$

64. Answer (3)

$\left(\overline{\overline{A}+\overline{B}}\right) = A \cdot B$

$\therefore \quad Y = \overline{A \cdot B} = \text{NAND gate}$

65. Answer (2)

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

$= (A+B)\cdot(\overline{A}+\overline{B})$

66. Answer (100)

Power gain = $\dfrac{R_{out}}{R_{in}}$ (Current gain)^2

$\Rightarrow 10^6 = \dfrac{10 \times 10^3}{100} \times \beta^2 \quad \Rightarrow \beta = 100$

67. Answer (1)

$\beta = \dfrac{\alpha}{1-\alpha}$ correct relation

$\Rightarrow \dfrac{1-\alpha}{\alpha} = \dfrac{1}{\beta}$

$\Rightarrow \dfrac{1}{\alpha} = 1 + \dfrac{1}{\beta} = \dfrac{\beta+1}{\beta}$

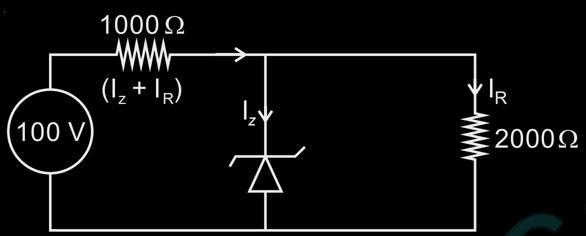
$\Rightarrow \alpha = \dfrac{\beta}{1+\beta}$

68. Answer (200)

$\beta = \dfrac{\Delta I_C}{\Delta I_B}$

$= \dfrac{2\times 10^{-3}}{10\times 10^{-6}} = 200$

69. Answer (2)



$I_R = \dfrac{50}{2000} = 2.5\times 10^{-2}$ A

$1000(I_R + I_z) = -50 + 100$

$\Rightarrow (I_R + I_z) = 0.05$

$I_z = 0.025$ A

70. Answer (192)

$P = V_z I_z \Rightarrow I_z = \dfrac{1}{16}$ A

$I_z = \dfrac{V - V_z}{R_P}$

$R_P = (20-8)\times 16 = 192\ \Omega$

71. Answer (25)

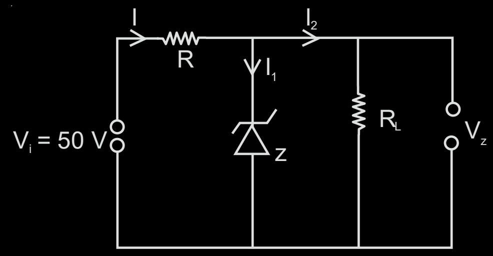
$R_D = \dfrac{\Delta V}{\Delta I} = \dfrac{0.1}{4\times 10^{-3}} = 25\ \Omega$

72. Answer (4)

Band gap = $\dfrac{hc}{\lambda} = 2$ eV

73. Answer (500)

$I = \dfrac{50 - V_z}{R} = \dfrac{5}{R_L} + 90\times 10^{-3}$



For $R_L \to \infty$

$R = 500\ \Omega$

74. Answer (4)

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

$\Rightarrow$ AND gate

75. Answer (5)

$n_e n_h = n_i^2$

$n_e = \dfrac{(1.5\times 10^{16})^2}{4.5\times 10^{22}} = 5\times 10^9\ /\text{m}^3$

76. Answer (25)

$\beta = \dfrac{I_C}{I_B}$, where $I_C = \dfrac{0.6}{1000} = 6\times 10^{-4}$ A

$\Rightarrow 24 = \dfrac{6\times 10^{-4}\ \text{A}}{x}$

$x = \dfrac{1}{4}\times 10^{-4}$ A $= 25\times 10^{-6}$ A

77. Answer (4)

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

78. Answer (1)

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

NOR GATE

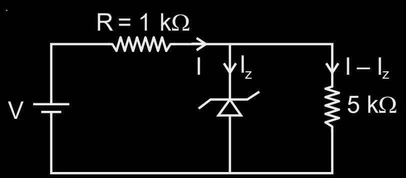
79. Answer (3)

Extra electron donated by pentavalent electron is available for conduction. So, statement I is correct but net charge is zero so statement II is false.

80. Answer (1)

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

81. Answer (120)



$$I - I_z = \frac{V_z}{R_L} = 2\text{ mA}$$

$$I = \frac{V - V_z}{R} = 14\text{ mA}$$

$\Rightarrow$ I_z = 12 mA

$P = V_z I_z$ = 120 mW

82. Answer (4)

In CE mode transistor is used as an amplifier in active region only

83. Answer (5)

The transistor is not sufficiently biased at

Base - Collector junction

$\Rightarrow$ $I_c = 0$

$\Rightarrow$ $V_0 = 5$ V

84. Answer (2)

We know, $I_E = I_C + I_B$

$$\frac{I_C}{\alpha} = I_C + \frac{I_C}{\beta}$$

$$\Rightarrow \frac{1}{\alpha} = 1 + \frac{1}{\beta}$$

$$\frac{1}{\beta} = \frac{1}{\alpha} - 1 \quad = \frac{1-\alpha}{\alpha}$$

$$\beta = \frac{\alpha}{1-\alpha}$$

85. Answer (20)

P_z = 2 W

V_z = 10 V

I_z = 0.2 A (max)

$I_{zmax} \times R_S = (14 - 10)$

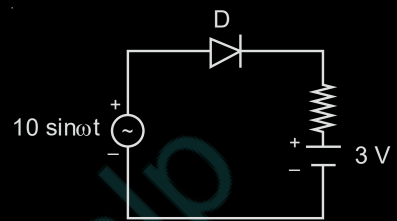
$R_S = 20\ \Omega$

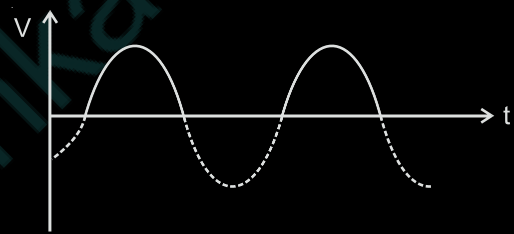
86. Answer (4)

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

87. Answer (4)

D will be forward biased if 10 sinωt > 3





88. Answer (1)

To get steady dc output from the pulsating voltage received from a full wave rectifier we can use capacitor.

Both statements are true.

89. Answer (3)

In case (A), current flows through R if either V_A or V_B is high leading to non zero output.

$\Rightarrow$ *A* represent OR Gate.

In case (*B*), for high input voltage, $I_B \neq 0$

So $I_C \neq 0$.

$V_O = V - I_C R_C$

V_O will be low.

90. Answer (1)

$$I_1 = \frac{V}{R_{eq}}$$

$$I_1 = \frac{200}{100} = 2\text{ A}$$

91. Answer (750)

$$R_B = \frac{10\times10^{-3}}{10\times10^{-6}}$$
$$= 10^3\ \Omega$$
$$\therefore\ A_V = \left(\frac{\Delta I_C}{\Delta I_B}\right)\times\left(\frac{R_C}{R_B}\right)$$
$$= \frac{1.5\times10^{-3}}{10\times10^{-6}}\times\frac{5\times10^3}{1\times10^3}$$
$$= \frac{1.5\times5}{10}\times(1000)$$
$$= 750$$

92. Answer (4)

A photodiode is reverse biased. When light falling on it produces charge carriers, the fractional change, in minority carriers is high since the original current is very small.

93. Answer (1)

According to the circuit,

$Y = (A' + B')'$

$\Rightarrow\ Y = AB$

$\Rightarrow$ AND gate

94. Answer (15)

$$\text{Voltage gain} = \frac{I_C R_o}{I_B R_i}$$
$$= \frac{(10\text{ mA})(60\ \Omega)}{(200\ \mu\text{A})(200\ \Omega)}$$

$\Rightarrow$ Voltage gain = 15

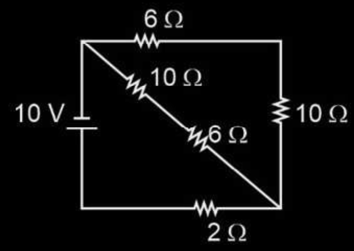
95. Answer (2)

$$\text{Dynamic resistance} = \frac{dV}{dI}$$
$$\Rightarrow\ r_1 = \frac{2.1-2}{10-5}\ \text{k}\Omega$$
$$\&\ r_2 = \frac{4.2-4}{250-200}\ \text{k}\Omega$$

$\Rightarrow\ r_1 : r_2 = 5 : 1.$

96. Answer (1)

Because of diode D_2 current will not flow through it so new circuit diagram is



so $R_{net} = 10\ \Omega$

and $i = \dfrac{V}{R_{net}} = 1\text{ A}$

97. Answer (2)

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

$\Rightarrow Y = (AB)' \Rightarrow$

98. Answer (4)

A transistor acts as a switch when it is operated in saturation and cut-off state.

99. Answer (4)

D_1 : conducting

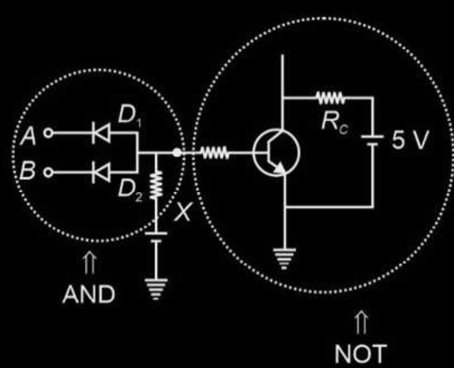
D_2 : open circuit

$$\Rightarrow\ i = \frac{1-0.6}{60+40}\text{ A}$$
$$= \frac{0.4}{100}\text{ A}$$

$\Rightarrow\ i = 4$ mA

100. Answer (3)

The shown circuit is a combination of AND gate and a NOT gate



$\Rightarrow\ Y = \overline{AB}$

Option (C) is a correct option.

101. Answer (2)

A diode is a two terminal device which conducts current in forward bias only

$\Rightarrow$ Option (2) is correct.

102. Answer (1)

(A) is true as n-p-n transistor permits more current than p-n-p transistor as electrons which are majority charge carriers in n-p-n have higher mobility than holes which are majority carriers in p-n-p transistor

$\Rightarrow$ Statement R is correct explanation of statement A

103. Answer (4)

Till $|V| \le 0.6V$ $\qquad$ $|V_0| = |V|$

So correct graph will be D.

104. Answer (2)

Minimum value of R_L for which the diode is shorted

is $\dfrac{R_L}{R_L + 100} \times 10 = 8 \Rightarrow R_L = 400\ \Omega$

For maximum value of R_L, current through diode is 10 mA

So $i_R = i_{R_L} + I_{ZM}$

$$\frac{2}{100} = \frac{8}{R_L} + 10 \times 10^{-3}$$

$$10 \times 10^{-3} = \frac{8}{R_L}$$

$R_L = 800\ \Omega$

So $\dfrac{R_{L\max}}{R_{L\min}} = 2$

105. Answer (2)

$$\text{Power gain} = \left[\frac{\Delta i_C}{\Delta i_B}\right]^2 \times \frac{R_o}{R_i}$$

$$= \left[\frac{10^{-2}}{10^{-4}}\right]^2 \times \frac{2}{1}$$

$$= 2 \times 10^4$$

$\Rightarrow$ $x = 2$

106. Answer (14)

Conserving energy,

$$\frac{1}{2}mv^2 = \frac{1}{2}m(6 \times 10^5)^2 - 0.4\,\text{eV}$$

$$\Rightarrow \quad v = \sqrt{(6 \times 10^5)^2 - \frac{2 \times 1.6 \times 10^{-19} \times 0.4}{9 \times 10^{-31}}}$$

$$= \sqrt{36 \times 10^{10} - \frac{1.28}{9} \times 10^{12}}$$

$$\Rightarrow \quad v = \frac{14}{3} \times 10^5 \text{ m/s}$$

$\Rightarrow$ $x = 14$

107. Answer (1)

Given circuit is equivalent to an AND gate.

$\therefore$

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

108. Answer (3)

Energy corresponding to wavelength 4000 Å

$$E = \frac{hc}{\lambda}$$

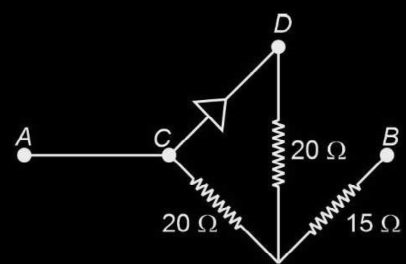
$$= \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{4000 \times 10^{-10} \times 1.6 \times 10^{-19}}\ \text{eV}$$

$$= \frac{12400}{4000}$$

$= 3.1$ eV

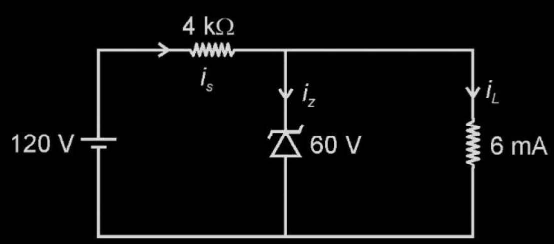
≈ 3 eV

109. Answer (25)



$$R = \frac{20 \times 20}{40} + 15 = 25\ \Omega$$

110. Answer (9)



$$i_s = \frac{60}{4\times10^3} = 15\times10^{-3} = 15 \text{ mA}$$

$$i_L = \frac{60}{10\times10^3} = 6 \text{ mA}$$

$I_z = i_s - i_L = 9$ mA

111. Answer (1)

From waveforms, it is an AND gate.

112. Answer (2)

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

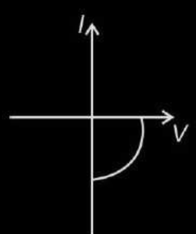
$$= \frac{(6-4)\times10^{-3}}{(25-20)\times10^{-6}}$$

$$= \frac{2}{5}\times10^3$$

$= 400$

113. Answer (2)

Solar cell characteristics



114. Answer (2)

$$\frac{V_o}{V_i} = \beta\times\left(\frac{R_C}{R_B}\right)$$

$$\Rightarrow\ V_o = 100\times\left(\frac{10}{1}\right)\times10^{-3}$$

$= 1.0$ V

115. Answer (1)

$$E = \frac{V}{d} = \frac{0.6}{6\times10^{-6}} = 1\times10^5$$

116. Answer (480)

R will be minimum when R_L is infinitely large, so

$$R_{\text{Zener}} = \frac{8}{25\times10^{-3}} = 320\ \Omega$$

So $\dfrac{R}{R_{\text{Zener}}} = \dfrac{12}{8}$

$$R = \frac{12}{8}\times320 = 480\ \Omega$$

117. Answer (200)

$$V_{\text{gain}} = \text{Current gain}\times\frac{R_L}{R_i}$$

$$= \frac{\Delta I_C}{\Delta I_B}\times\frac{R_L}{R_i}$$

$$= \frac{5\times10^{-3}}{100\times10^{-6}}\times\frac{2\times10^3}{0.5\times10^3} = \frac{10}{0.5}\times10 = 200$$

118. Answer (5)

$V_L = 5$ V as $V_z = 5$ V

$$\therefore\ I_L = \frac{V_L}{R_L} = \frac{5}{10^3} = 5 \text{ mA}$$

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