PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

SEMICONDUCTOR ELECTRONICS

Examples

1. C, Si and Ge have same lattice structure. Why is C insulator, while Si and Ge intrinsic semiconductors ?

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2. Suppose a pure Si-crystal has $5 \times 10^{28} \text{atoms} m^{-3}$. It is doped by 1 ppm concentration of pentavalent As. Calculate the number of electrons and holes. Give that $n_i = 1.5 \times 10^{16} m^{-3}$.

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3. Can we take one slab of p - type semiconductor and physically

join it to another n - type semiconductor to get p - n junction?

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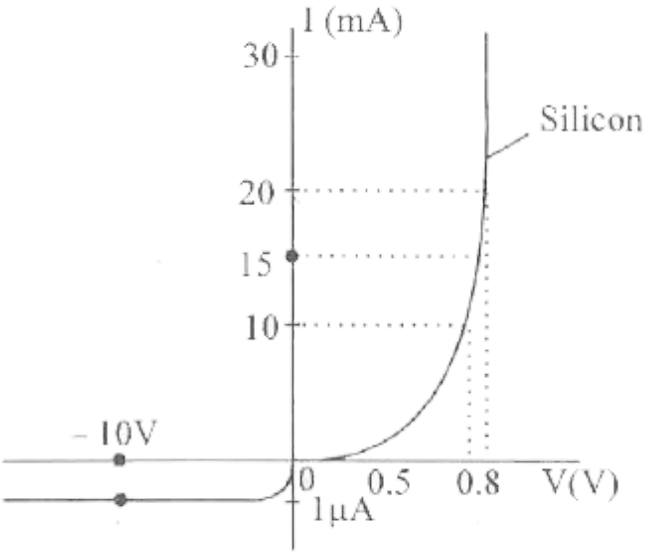
4. The V-I characteristic of a silicon diode is shown in the figure . Calculate the resistance of the diode at (a) $I_D = 15mA$ and (b)

$V_D = -10V$



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5. In a Zener regulated power supply , a Zener diode with $V_Z = 6.0$ V is used for regulation . The load current is to be 4.0 mA and the

unregulated input is 10.0 V . What should be the value of series resistor R_S ?

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6. The current in the forward bias is unknown to be more (~mA) than the current in the reverse bias (~μA). What is the reason then to operate the photo diodes in reverse bias ?

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7. Why are Si and GaAs are preferred materials for solar cells?

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8. Justify the output waveform (Y) of the OR gate for the following inputs A and B given in the figure below .

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9. Take A and B input waveforms similar to that in Ex. Sketch the output waveform obtained from AND gate .

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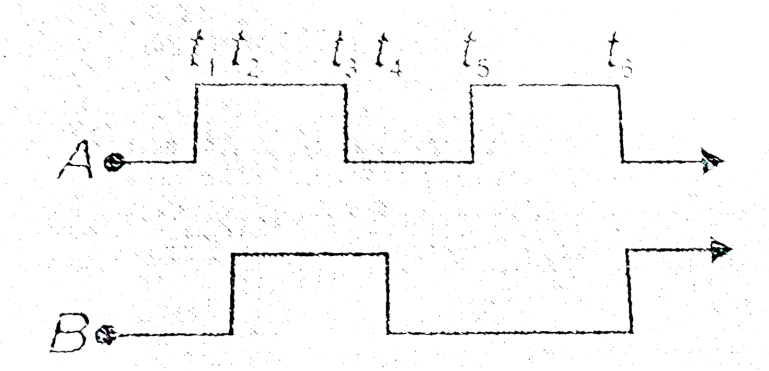
10. Sketch the output wavefrom Y from a NAND gate having following inputs A and B



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Exercises

1. In an n- type silicon, which of the following statements is true ?

(a) Electrons are majority carries and trivalent atoms are the dopants.

(b) Electrons are majority carries and pentavalent atoms are the dopants.

(c) Holes are minority carries and paentavalent atoms are the dopants.

(d) Holes are minority carries and trivalent atoms are the dopants.

A. Electrons are majority carriers and trivalent atoms are the dopants.

B. Electrons are minority carriers and pentavalent atoms are the dopants.

C. Holes are minority carriers and pentavalent atoms are the dopants.

D. Holes are majority carriers and trivalent atoms are the dopants

Answer: c

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2. Which of the statements given in above example is true for p - type semiconductors ?

A. Electrons are majority carriers and trivalent atoms are the dopants.

B. Electrons are minority carriers and pentavalent atoms are the dopants.

C. Holes are minority carriers and pentavalent atoms are the dopants.

D. Holes are majority carriers and trivalent atoms are the dopants

Answer: d

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3. Carbon , silicon and germanium have four valence elcectrons each . These are characterised by valence and conduction

bands separated by energy band - gap respectively equal to $(E_g)_c (E_g)_{si}$ and $(E_g)_{Ge}$. Which of the following statements ture ?

A. $(E_g)_{Si} < (E_g)_{Ge} < (E_g)_C$

B. $(E_g)_C < (E_g)_{Ge} > (E_g)_{Si}$

C. $(E_g)_C > (E_g)_{Si} > (E_g)_{Ge}$

D. $(E_g)_C = (E_g)_{Si} = (E_g)_{Ge}$

Answer: c

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4. In an unbiased p-n junction holes diffuse from the p-region to the n-region because

A. free electrons in the n-region attract them.

B. they move across the junction by the potential difference.

C. hole concentration in p-region is more as compared to n-region.

D. All the above.

Answer: c

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5. When a forward bias is applied to a p -n junction. It

A. raises the potential barrier.

B. reduces the majority carrier current to zero.

C. lowers the potential barrier.

D. None of the above.

Answer: c

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6. In half - wave rectification, what is the output frequency, if the input frequency is 50 Hz ? What is the output frequency of a full - wave rectifier for the same input frequency ?

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7. A p-n junction is fabricated from a semiconductor with band gap of $2.8eV$. Can it detect a wavelength of $6000nm$?

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Additional Exercises

1. The number of silicon atoms per $m^3 is 5 \times 10^{28}$. This is doped simultaneously with 5×10^{22} atoms per m^3 of Arsenic and

$5 \times 10^{20} perm^3$ atoms of indium. Calculate the number of electrons and holes. Given that $n_i = 1.5 \times 10^{16} m^{-3}$. Is the material n-type or p-type?

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2. In an intrinsic semiconductor the energy gap $E_g is 1.2eV$. Its hole mobility is much smaller than electron mobility and independent of temperature. What is the ratio between conductivity at $600K$ and $300K$?

Assume that temperature dependence intrinstic concentration n_i is given by $n_i = n_0 \exp\left(\frac{-E_g}{2k_T}\right)$, where n_0 is a constant and $k_= 8.62 \times 10^{-5} eV/K$.

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3. In a $p-n$ junction diode, the currect I can expressed as $I = I_0 \exp\left(\frac{eV}{2k_BT} - 1\right)$ where I_0 is called the reverse saturation current, V is the voltage across the diode and is positive for forward bias and negative for reverse bias,

and I is the current through the diode, K_B is the Boltzmann constant $\left(8.6 \times 10^{-5} eV / K\right)$ and T is the absolute temperature. If for a given diode $I_o = 5 \times 10^{-12} A$ and $T = 300K$, then

(a) What will be the forward current at a formward voltage of $0.6V$?

(b) What will be the increase in the current if the voltage across the diode is increased to $0.7V$?

(c) What is the dynamic resistance ?

(d) What will be current if reverse bias voltage changes from $1V$ to $2V$?

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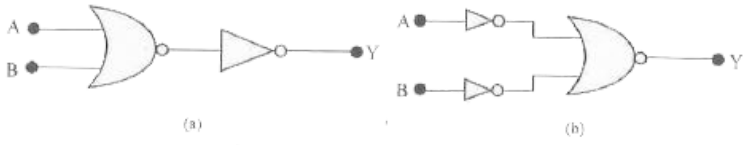
4. You are given the two circuits as shown in fig. show that circuit (a) acts as OR gate while the circuit (b) acts as AND gate .



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5. Write the truth table for a NAND gate connected as given in Fig. 14.37.

Hence identify the exact logic operation carried out by this circuit.

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6. You are given two circuits as shown in fig. which consist of NAND gates . Identify the logic operation carried out by the two circuits

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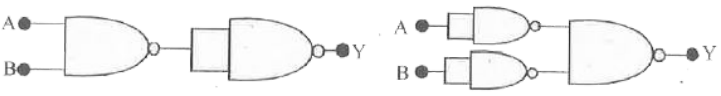

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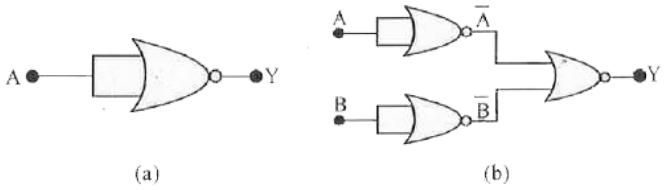
7. Write the truth table for the circuits gives in figure consisting of NOR gates only . Identify the logic operations (OR , AND , NOT) performed by the two circuits .



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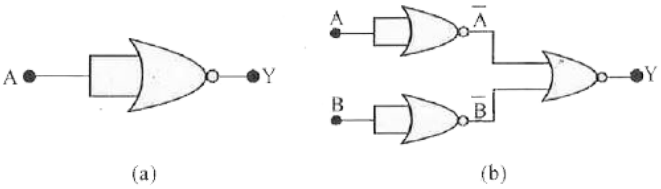
8. Write the truth table for the circuits gives in figure consisting of NOR gates only . Identify the logic operations (OR , AND , NOT) performed by the two circuits .



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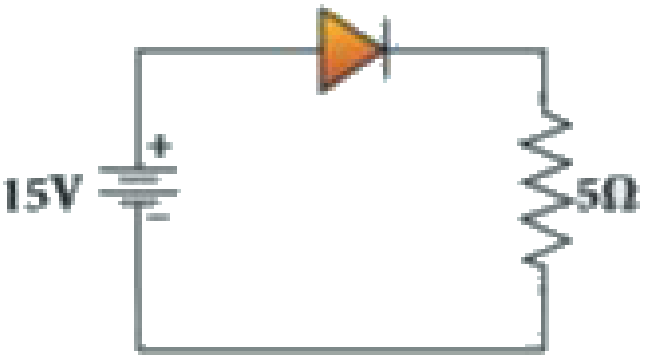
Example

1. An ideal diode and a 5Ω resistor are connected in series with a 15 V power supply as shown in figure below. Calculate the current that flows through the diode.



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2. Consider an ideal junction diode. Find the value of current flowing through AB is

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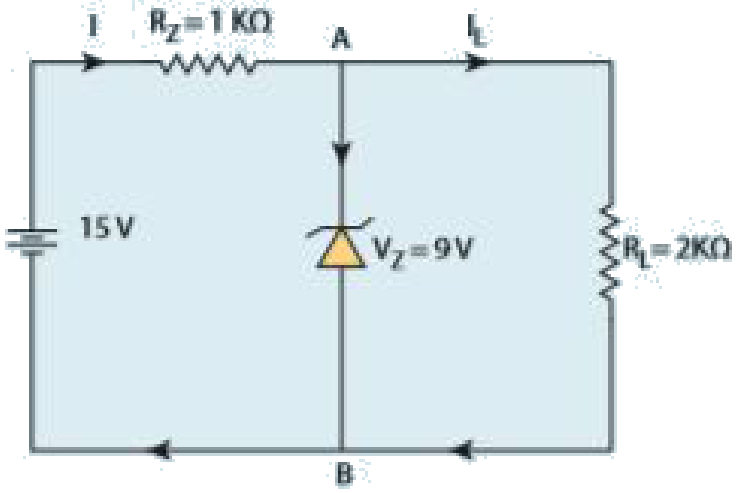
3. Find the current through the Zener diode when the load resistance is $1K\Omega$. Use diode

approximation.



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4. Determine the wavelength of light emitted from LED which is made up of GaAsP semiconductor whose forbidden energy gap is

1.875 eV. Mention the colour of the light emitted (Take $h = 6.6 \times 10^{-34}$ Js).

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5. In a transistor connected in the common base configuration, $\alpha = 0.95, I_E = 1mA$ Calculate the values of I_C and I_B

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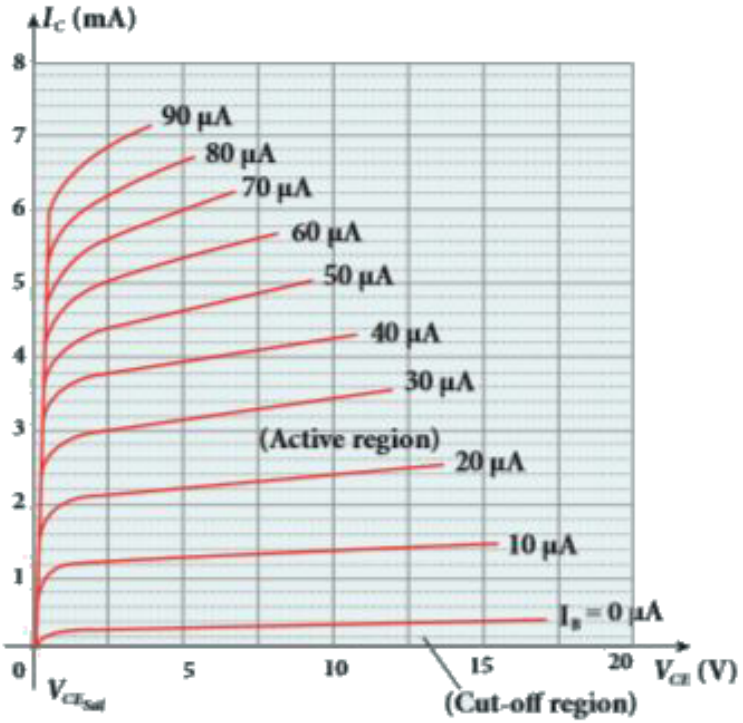
6. The output characteristics of a transistor connected in common emitter mode is shown in the figure. Determine the value of I_C when $V_{CE} = 15V$. Also determine the value of I_C when V_{CE} is changed to 10 V



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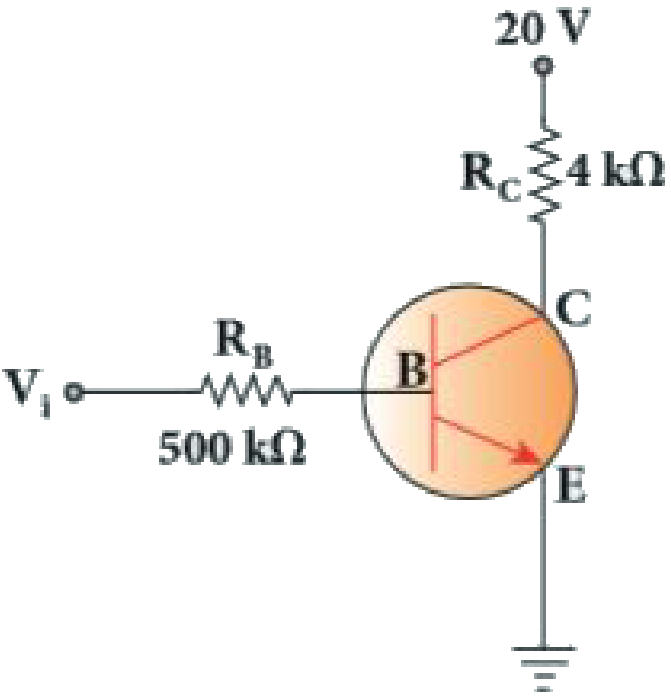
7. In the circuit shown in the figure, the input voltage V_i is 20 V, $V_{BE} = 0V$ and $V_{CE} = 0V$. What are the values of I_B, I_C, β ?



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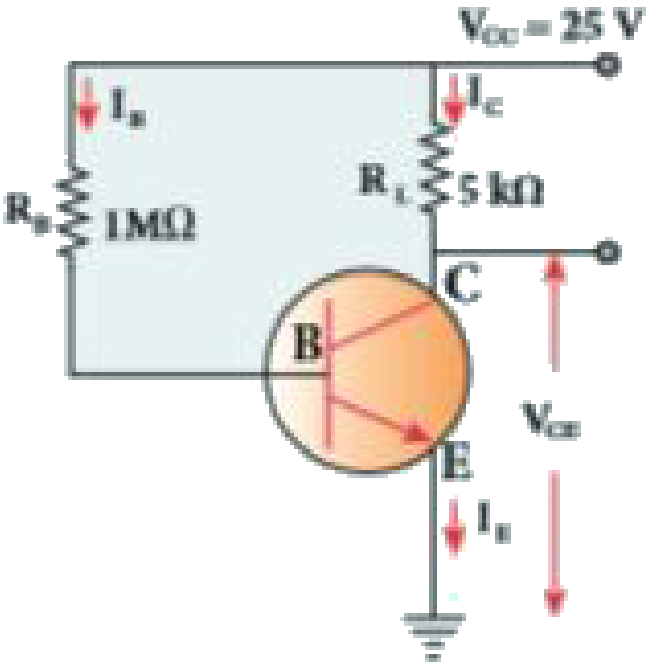
8. The current gain of a common emitter transistor circuit shown in figure is 120. Draw the dc load line and mark the Q point on it. (

V_{BE} to be ignored).



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9. Calculate the range of the variable capacitor that is to be used in a tuned-collector

oscillator which has a fixed inductance of $150\mu H$. The frequency band is from 500 kHz to 1500 kHz.

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10. What is the output Y in the following circuit, when all the three inputs A, B, and C are first 0 and then 1?

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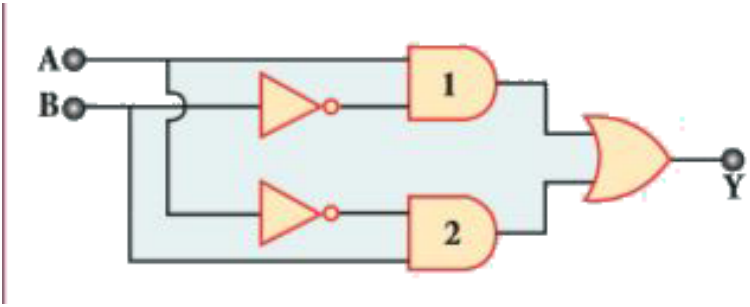
11. In the combination of the following gates, write the Boolean equation for output Y in terms of inputs A and B.



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12. Simplify the Boolean identity

AC + ABC = AC

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Evaluation I Multiple Choice Questions

1. Th e barrier potential of a silicon diode is approximately,

A. 0.7 V

B. 0.3V

C. 2.0 V

D. 2.2V

Answer: A

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2. Doping a semiconductor results in

A. The decrease in mobile charge carriers

B. The change in chemical properties

C. The change in the crystal structure

D. The breaking of the covalent bond

Answer: C

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3. A forward biased diode is treated as

A. An open switch with infinite resistance

B. A closed switch with a voltage drop of 0V

C. A closed switch in series with a battery voltage of 0.7V

D. A closed switch in series with a small resistance and a battery.

Answer: D

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4. If a half - wave rectified voltage is fed to a load resistor, which part of a cycle the load current will flow?

A. $0^\circ - 90^\circ$

B. $90^\circ - 180^\circ$

C. $0^\circ - 180^\circ$

D. $0^\circ - 360^\circ$

Answer: C

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5. The primary use of a zener diode is

A. Rectifier

B. Amplifier

C. Oscillator

D. Voltage regulator

Answer: D

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6. The principle in which a solar cell operates

A. Diffusion

B. Recombination

C. Photovoltaic action

D. Carrier flow

Answer: C

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7. The light emitted in an LED is due to

A. Recombination of charge carriers

B. Reflection of light due to lens action

C. Amplification of light falling at the junction

D. Large current capacity

Answer: A

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8. When a transistor is fully switched on, it is said to be

A. Shorted

B. Saturated

C. Cut-off

D. Open

Answer: B

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9. The specifi c characteristic of a common emitter amplifier is

A. High input resistance

B. Low power gain

C. Signal phase reversal

D. Low current gain

Answer: C

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10. To obtain sustained oscillation in an oscillator,

A. Feedback should be positive

B. Feedback factor must be unity

C. Phase shift must be 0 or 2π

D. All the above

Answer: D

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11. If the input to the NOT gate is A = 1011, its output is

A. 0100

B. 1000

C. 1100

D. 0011

Answer: A

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12. The electrical series circuit in digital form is

A. AND

B. OR

C. NOR

D. NAND

Answer: A

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13. Which one of the following represents forward bias diode?

A. 

B. 

C. 

D. 

Answer: A

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