Chapter 37, Problem 2

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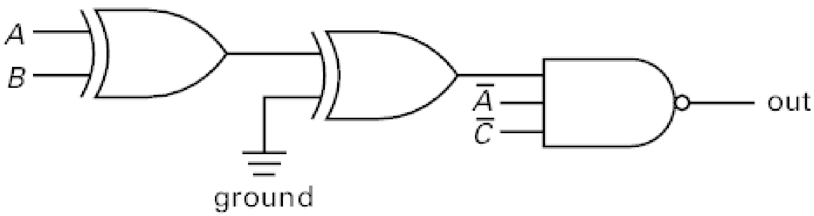
Test Bank

Question preview

Question

What is the output of the following logic circuit?



Answers

(A) $A \cdot B \cdot C$

(B) $A \cdot B \cdot C + A \cdot C$

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

(D) $A \cdot \overline{B} \cdot C$

The answer is (A).

Solution

Determine the Boolean logic expression from the logic circuit.

$$\text{out} \quad = A \cdot C \cdot (\overline{0 + A \oplus B})$$

The logic "0" on the NOR gate makes the NOR gate effectively an inverter gate.

$$\overline{0 + A \oplus B} \quad = \overline{A \oplus B}$$

The output is

$$\text{out} \quad = A \cdot C \cdot (\overline{A \oplus B})$$

The EXCLUSIVE-OR is equivalent to the conditions that will make the output true when the inputs are different.

$$A \oplus B \quad = A \cdot \overline{B} + \overline{A} \cdot B$$

The negation of the EXCLUSIVE-OR is

$$\overline{A \oplus B} \quad = \overline{A \cdot \overline{B} + \overline{A} \cdot B}$$

Apply De Morgan's theorem to the negation of the EXCLUSIVE-OR.

QUESTION DATA

Vendor

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Solving Time

<2

Difficulty

easy

Quantitative?

Yes

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$$\begin{aligned}\overline{A \oplus B} &= \overline{A \cdot \overline{B} + \overline{A} \cdot B} = \left(\overline{A \cdot \overline{B}}\right) \cdot \left(\overline{\overline{A} \cdot B}\right) \\ &= \left(\overline{A} + B\right) \cdot \left(A + \overline{B}\right)\end{aligned}$$

The AND is distributive over the OR, so the terms can be distributed analogously to cross multiplication in regular algebra.

$$\begin{aligned}\overline{A \oplus B} &= \left(\overline{A} + B\right) \cdot \left(A + \overline{B}\right) \\ &= A \cdot \overline{A} + A \cdot B + \overline{A} \cdot \overline{B} + B \cdot \overline{B} \\ &= 0 + A \cdot B + \overline{A} \cdot \overline{B} + 0 \\ &= A \cdot B + \overline{A} \cdot \overline{B}\end{aligned}$$

Substitute this result into the equation for the output and simplify.

$$\begin{aligned}\text{out} &= A \cdot C \cdot (\overline{A \oplus B}) \\ &= A \cdot C \cdot \left(A \cdot B + \overline{A} \cdot \overline{B}\right) \\ &= A \cdot C \cdot A \cdot B + A \cdot C \cdot \overline{A} \cdot \overline{B} \\ &= A \cdot A \cdot B \cdot C + A \cdot \overline{A} \cdot \overline{B} \cdot C \\ &= A \cdot B \cdot C + 0 \cdot \overline{B} \cdot C \\ &= A \cdot B \cdot C\end{aligned}$$

Chapter 16, Problem 1

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Test Bank

Question preview

Question

A 9 V battery is connected across a semiconductor with a resistive diffused layer 1 cm wide, 10 cm long, and 1 cm thick. The diffused layer is doped with an *n*-type dopant to a concentration of 8.34 × 10^{17} carriers/cm^3. The intrinsic carrier concentration in the diffused layer is 10^{10} carriers/cm^3, the mobility of holes is 150 cm^2/V·s, and the electron mobility is 360 cm^2/V·s. Most nearly, what is the current through the diffused layer?

Answers

(A) 0.12 A

(B) 18 A

(C) 43 A

(D) 61 A

The answer is (C).

Solution

Use the law of mass action to find the hole concentration.

$$(p)(n) = n_i^2$$

$$p = \frac{n_i^2}{n} = \frac{\left(1.0\times10^{10}\ \frac{\text{carriers}}{\text{cm}^3}\right)^2}{8.34\times10^{17}\ \frac{\text{carriers}}{\text{cm}^3}} = 1.20\times10^2\ \text{carriers/cm}^3$$

The conductivity of the semiconductor is

$$\begin{aligned}\sigma &= q\left(n\mu_n + p\mu_p\right)\\ &= \left(1.6\times10^{-19}\ \text{C}\right)\left(\begin{array}{c}\left(8.34\times10^{17}\ \frac{\text{carriers}}{\text{cm}^3}\right)\left(360\ \frac{\text{cm}^2}{\text{V}\cdot\text{s}}\right)\\ +\left(1.20\times10^{2}\ \frac{\text{carriers}}{\text{cm}^3}\right)\left(150\ \frac{\text{cm}^2}{\text{V}\cdot\text{s}}\right)\end{array}\right)\\ &= 48.04\ \text{S/cm}\end{aligned}$$

Resistivity is the reciprocal of conductivity.

$$\rho = \frac{1}{\sigma} = \frac{1}{48.04\ \frac{\text{S}}{\text{cm}}} = 0.0208\ \Omega\cdot\text{cm}$$

QUESTION DATA

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Yes

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Electrical and Compute

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The sheet resistance is

$$R_s = \frac{\rho}{d} = \frac{0.0208\ \Omega\cdot\text{cm}}{1\ \text{cm}}$$
$$= 0.0208\ \Omega \quad \text{(per square)}$$

The resistance of the diffused layer is

$$R = R_s\left(\frac{L}{W}\right) = (0.0208\ \Omega)\left(\frac{10\ \text{cm}}{1\ \text{cm}}\right)$$
$$= 0.208\ \Omega$$

Use Ohm's law to find the current through the diffused layer.

$$V = IR$$
$$I = \frac{V}{R} = \frac{9\ \text{V}}{0.208\ \Omega}$$
$$= 43.3\ \text{A} \quad (43\ \text{A})$$

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Chapter 27, Problem 3

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Test Bank Question preview

Question

A lossless transmission line has a length of 30 m and a characteristic impedance of 50 Ω. The line operates at 5 MHz with a load impedance of 60 Ω + *j*40 Ω. The propagation constant is 1.396 rad/m. Most nearly, the input impedance seen by the source is

Answers

(A) 55.9 Ω∠−31.0°

(B) 55.9 Ω∠−35.7°

(C) 66.9 Ω∠−35.7°

(D) 69.9 Ω∠−33.2°

The answer is (C).

Solution

Use the equation for transmission line impedance at a point. The phase angle of the impedance at the source is

$$\beta d = \left(\left(1.396\ \frac{\text{rad}}{\text{m}}\right)\left(\frac{180^\circ}{\pi}\right)\right)(30\ \text{m}) = 2400^\circ$$

The input impedance seen by the source is

$$\begin{aligned}\mathbf{Z}_{\text{in}}(d) &= \mathbf{Z}_0 \frac{\mathbf{Z}_L + j\mathbf{Z}_0 \tan(\beta d)}{\mathbf{Z}_0 + j\mathbf{Z}_L \tan(\beta d)} \\ &= (50\ \Omega)\left(\frac{60\ \Omega + j40\ \Omega + (j50\ \Omega)\tan 2400^\circ}{50\ \Omega + (j60\ \Omega - 40\ \Omega)\tan 2400^\circ}\right) \\ &= (50\ \Omega)\left(\frac{60 + j125}{-18 + j102}\right)\left(\frac{-18 - j102}{-18 - j102}\right) \\ &= (50\ \Omega)\left(\frac{11{,}652 + j8370}{10{,}728}\right) \\ &= 54.3\ \Omega + j39.01\ \Omega\end{aligned}$$

Converting from rectangular form to polar form,

$$r = \sqrt{(54.3\ \Omega)^2 + (39.01\ \Omega)^2} = 66.86\ \Omega$$

$$\theta = \arctan \frac{39.01\ \Omega}{54.3\ \Omega} = 35.69^\circ$$

$$Z_{\text{in}}(d) = 66.86\ \Omega\angle{-35.69^\circ} \quad (66.9\ \Omega\angle{-35.7^\circ})$$

QUESTION DATA

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Chapter 8, Problem 3

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Test Bank

Question preview

Question

What is the general solution to the following differential equation?

$$y'' + y' + y = 0$$

Answers

(A) $y = e^{-(1/2)x}\left(C_1 \cos \frac{\sqrt{3}}{2}x + C_2 \sin \frac{\sqrt{3}}{2}x\right)$

(B) $y = e^{-(1/2)x}\left(C_1 \cos \frac{3}{2}x + C_2 \sin \frac{3}{2}x\right)$

(C) $y = e^{-2x}\left(C_1 \cos \frac{\sqrt{3}}{2}x + C_2 \sin \frac{\sqrt{3}}{2}x\right)$

(D) $y = e^{-2x}\left(C_1 \cos \frac{3}{2}x + C_2 \sin \frac{3}{2}x\right)$

The answer is (A).

Solution

This is a second-order, homogeneous, linear differential equation with $a = b = 1$. This differential equation can be solved by the method of undetermined coefficients with a solution in the form $y = Ce^{rx}$. The substitution of the solution gives

$$\left(r^2 + ar + b\right) Ce^{rx} = 0$$

Because Ce^{rx} can never be zero, the characteristic equation is

$$r^2 + ar + b = 0$$

Because $a^2 = 1 < 4b = 4$, the general solution is in the form

$$y = e^{\alpha x}\left(C_1 \cos \beta x + C_2 \sin \beta x\right)$$

Then,

$$\alpha = -\frac{a}{2} = -1/2$$

$$\beta = \sqrt{\frac{4b - a^2}{2}} = \sqrt{\frac{(4)(1) - (1)^2}{2}} = \sqrt{3}/2$$

Therefore, the general solution is

$$y = e^{-(1/2)x}\left(C_1 \cos \frac{\sqrt{3}}{2}x + C_2 \sin \frac{\sqrt{3}}{2}x\right)$$

QUESTION DATA

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Difficulty

easy

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No

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Chapter 37, Problem 1

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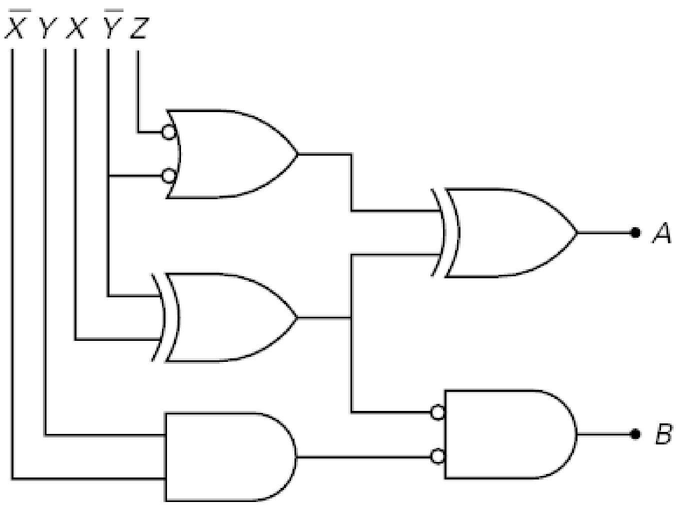
Test Bank

Question preview

Question

In the circuit shown, $X = 1$, $Y = 0$, and $Z = 1$.



What are the outputs, A and B?

Answers

(A) $A = 0$, $B = 0$

(B) $A = 0$, $B = 1$

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

(D) $A = 1$, $B = 1$

The answer is (B).

Solution

The NAND gate at the top left has inputs 1 and 1, so the condition is not satisfied and the output is 0.

The XOR gate at the middle left has inputs 1 and 1, so the condition is not satisfied and the output is 0.

The AND gate at the bottom left has inputs 0 and 0, so the condition is not satisfied and the output is 0.

The XOR gate at the top right has inputs 0 and 0, so the condition is not satisfied and the output is $A = 0$.

The NOR gate at the bottom right has inputs 0 and 0, so the condition is satisfied and the output is $B = 1$.

QUESTION DATA

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0000089055
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