Step 1 of 4

(a)

According to ohms law relation between V , I and R is $V = RI$

Resistance R is $1\ \mathrm{k\Omega}$

Voltage V is $5\ \mathrm{V}$

$$V = RI$$
$$5\ \mathrm{V} = (1000\ \Omega)I$$
$$I = \frac{5\ \mathrm{V}}{1000\ \Omega}$$
$$I = 5\ \mathrm{mA}$$

Current I is $\boxed{5\ \mathrm{mA}}$

Step 2 of 4

(b)

Voltage V is $5\ \mathrm{V}$

Current I is $1\ \mathrm{mA}$

$$V = RI$$
$$5\ \mathrm{V} = R(1\times10^{-3}\ \mathrm{A})$$
$$R = \frac{5\ \mathrm{V}}{10^{-3}\ \mathrm{A}}$$
$$R = 5\ \mathrm{k\Omega}$$

Resistance R is $\boxed{5\ \mathrm{k\Omega}}$

Step 3 of 4

(c)

Resistance R is $10\ \mathrm{k\Omega}$

Current I is $0.1\ \mathrm{mA}$

$$V = RI$$
$$V = (10\times10^{3}\ \Omega)(0.1\times10^{-3}\ \mathrm{A})$$
$$V = 1\ \mathrm{V}$$

Voltage V is $\boxed{1\ \mathrm{V}}$

Step 4 of 4

(d)

Resistance R is $100\ \Omega$

Voltage V is $5\ \mathrm{V}$

$$V = RI$$
$$5\ \mathrm{V} = (100\ \Omega)I$$
$$I = \frac{5\ \mathrm{V}}{100\ \Omega}$$
$$I = 50\ \mathrm{mA}$$

Current I is $\boxed{50\ \mathrm{mA}}$

1.002E

Calculate the source resistance.

$$R_s = \frac{v_{oc}}{i_{sc}}$$

Here,

v_{oc}, is the open circuit voltage.

i_{sc}, is the short circuit voltage.

Substitute 10 mV for v_{oc} and $10\,\mu\text{A}$ for i_{sc} .

$$\begin{aligned} R_s &= \frac{10\times10^{-3}}{10\times10^{-6}} \\ &= \frac{1}{1\times10^{-3}} \\ &= 1\times10^{3} \\ &= 1\text{ k}\Omega \end{aligned}$$

Therefore, the source resistance, R_s is $\boxed{1\text{ k}\Omega}$.

Step 1 of 7

(a)

Value of resistance R is $1\ \text{k}\Omega$

Current flowing through $1\ \text{k}\Omega$ resistor is $20\ \text{mA}$

Power (P) dissipated in the resistor is I^2R

$$\begin{aligned} P &= I^2R \\ &= \left(20\times10^{-3}\right)^2(1000\ \Omega) \\ &= 0.4\ \text{W} \end{aligned}$$

Power (P) dissipated in $1\ \text{k}\Omega$ resistor is $0.4\ \text{W}$

For safe operation standard component having power rating greater than $0.4\ \text{W}$ should be selected and hence $1/2\ \text{W}$ or $1\ \text{W}$ or $2\ \text{W}$ power rating components are used.

Step 2 of 7

(b)

Value of resistance R is $1\ \text{k}\Omega$

Current flowing through $1\ \text{k}\Omega$ resistor is $40\ \text{mA}$

Power (P) dissipated in the resistor is I^2R

$$\begin{aligned} P &= I^2R \\ &= \left(40\times10^{-3}\right)^2(1000\ \Omega) \\ &= 1.6\ \text{W} \end{aligned}$$

Power (P) dissipated in $1\ \text{k}\Omega$ resistor is $1.6\ \text{W}$

For safe operation standard component having power rating greater than $1.6\ \text{W}$ should be selected and hence $2\ \text{W}$ power rating components are used

Step 3 of 7

(c)

Value of resistance R is $100\ \text{k}\Omega$

Current flowing through $100\ \text{k}\Omega$ resistor is $1\ \text{mA}$

Power (P) dissipated in the resistor is I^2R

$$\begin{aligned} P &= I^2R \\ &= \left(1\times10^{-3}\right)^2(100000\ \Omega) \\ &= 0.1\ \text{W} \end{aligned}$$

Power (P) dissipated in $100\ \text{k}\Omega$ resistor is $0.1\ \text{W}$

For safe operation standard component having power rating greater than $0.1\ \text{W}$ should be selected and hence $1/8\ \text{W}$ or $1/4\ \text{W}$ or $1/2\ \text{W}$ or $1\ \text{W}$ or $2\ \text{W}$ power rating components are used

Step 4 of 7

(d)

Value of resistance R is $10\ \text{k}\Omega$

Current flowing through $10\ \text{k}\Omega$ resistor is $4\ \text{mA}$

Power (P) dissipated in the resistor is I^2R

$$\begin{aligned} P &= I^2R \\ &= \left(4\times10^{-3}\right)^2(10000\ \Omega) \\ &= 0.16\ \text{W} \end{aligned}$$

Power (P) dissipated in $10\ \text{k}\Omega$ resistor is $0.16\ \text{W}$

For safe operation standard component having power rating greater than $0.16\ \text{W}$ should be selected and hence $1/4\ \text{W}$ or $1/2\ \text{W}$ or $1\ \text{W}$ or $2\ \text{W}$ power rating components are used

Step 5 of 7

(e)

Value of resistance R is $1\ \text{k}\Omega$

Voltage drop across the resistance is $20\ \text{V}$

Power (P) dissipated in the resistor is $\frac{V^2}{R}$

$$\begin{aligned} P &= \frac{V^2}{R} \\ &= \frac{(20)^2}{1\ \text{k}\Omega} \\ &= 0.4\ \text{W} \end{aligned}$$

Power (P) dissipated in $1\ \text{k}\Omega$ resistor is $0.4\ \text{W}$

For safe operation standard component having power rating greater than $0.4\ \text{W}$ should be selected and hence $1/2\ \text{W}$ or $1\ \text{W}$ or $2\ \text{W}$ power rating components are used

Step 6 of 7

(f)

Value of resistance R is $1\ \text{k}\Omega$

Voltage drop across the resistance is $11\ \text{V}$

Power (P) dissipated in the resistor is $\frac{V^2}{R}$

$$\begin{aligned} P &= \frac{V^2}{R} \\ &= \frac{(11)^2}{1\ \text{k}\Omega} \\ &= 0.121\ \text{W} \end{aligned}$$

Step 7 of 7

Power (P) dissipated in $1\ \text{k}\Omega$ resistor is $0.121\ \text{W}$

For safe operation standard component having power rating greater than $0.121\ \text{W}$ should be selected and hence $1/8\ \text{W}$ or $1/4\ \text{W}$ or $1/2\ \text{W}$ or $1\ \text{W}$ or $2\ \text{W}$ power rating components are used

Step 1 of 6

Draw the circuit diagram.

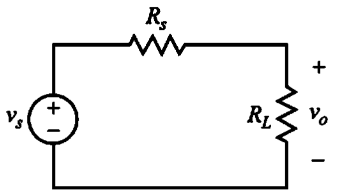

Figure 1

Step 2 of 6

The output voltage that appears across the load resistance is,

$$v_o = v_s\left(\frac{R_L}{R_L + R_s}\right)$$

Calculate the output voltage for $R_L = 100\ \text{k}\Omega$.

Substitute 100×10^3 for R_L, 1×10^3 for R_s and 10 mV for v_s.

$$\begin{aligned} v_o &= v_s\left(\frac{R_L}{R_L + R_s}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{100\times10^3}{100\times10^3+1\times10^3}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{100}{101}\right) \\ &= 9.9\ \text{mV} \end{aligned}$$

Therefore, the output voltage, v_o for $R_L = 100\ \text{k}\Omega$ is $\boxed{9.9\ \text{mV}}$.

Step 3 of 6

Calculate the output voltage for $R_L = 10\ \text{k}\Omega$.

$$v_o = v_s\left(\frac{R_L}{R_L + R_s}\right)$$

Substitute 10×10^3 for R_L, 1×10^3 for R_s and 10 mV for v_s.

$$\begin{aligned} v_o &= v_s\left(\frac{R_L}{R_L + R_s}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{10\times10^3}{10\times10^3+1\times10^3}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{10}{11}\right) \\ &= 9.1\ \text{mV} \end{aligned}$$

Therefore, the output voltage, v_o for $R_L = 10\ \text{k}\Omega$ is $\boxed{9.1\ \text{mV}}$.

Step 4 of 6

Calculate the output voltage for $R_L = 1\ \text{k}\Omega$.

$$v_o = v_s\left(\frac{R_L}{R_L + R_s}\right)$$

Substitute 1×10^3 for R_L, 1×10^3 for R_s and 10 mV for v_s.

$$\begin{aligned} v_o &= v_s\left(\frac{R_L}{R_L + R_s}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{1\times10^3}{1\times10^3+1\times10^3}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{1}{2}\right) \\ &= 5\ \text{mV} \end{aligned}$$

Therefore, the output voltage, v_o for $R_L = 1\ \text{k}\Omega$ is $\boxed{5\ \text{mV}}$.

Step 5 of 6

Calculate the output voltage for $R_L = 100\ \Omega$.

$$v_o = v_s\left(\frac{R_L}{R_L + R_s}\right)$$

Substitute 100 for R_L, 1×10^3 for R_s and 10 mV for v_s.

$$\begin{aligned} v_o &= v_s\left(\frac{R_L}{R_L + R_s}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{100}{100+1\times10^3}\right) \\ &= \left(10\times10^{-3}\right)\left(\frac{100}{1100}\right) \\ &= 0.9\ \text{mV} \end{aligned}$$

Therefore, the output voltage, v_o for $R_L = 100\ \Omega$ is $\boxed{0.9\ \text{mV}}$.

Step 6 of 6

The output voltage is 80 % of the source voltage.
That is, $v_o = 0.8\,v_s$.

Write the formula for output voltage.

$$v_o = v_s\left(\frac{R_L}{R_L + R_s}\right)$$

Substitute $1\ \text{k}\Omega$ for R_s and $0.8\,v_s$ for v_o.

$$0.8v_s = v_s\left(\frac{R_L}{R_L + 1\times10^3}\right)$$

$$0.8 = \left(\frac{R_L}{R_L + 1\times10^3}\right)$$

$$0.8R_L + 800 = R_L$$

$$0.2R_L = 800$$

$$\begin{aligned} R_L &= 4000\ \Omega \\ &= 4\ \text{k}\Omega \end{aligned}$$

Therefore, the load resistance, R_L is $\boxed{4\ \text{k}\Omega}$.

Step 1 of 5

(a)

Resistance R is $1\ \text{k}\Omega$

Current I is $5\ \text{mA}$

According to ohms law $V = IR$

$$\begin{aligned} V &= IR \\ &= \left(5\times10^{-3}\ \text{A}\right)\left(1000\ \Omega\right) \\ &= 5\ \text{V} \end{aligned}$$

Voltage V is $\boxed{5\ \text{V}}$

According to power law $P = VI$

$$\begin{aligned} P &= VI \\ &= \left(5\ \text{V}\right)\left(5\times10^{-3}\ \text{A}\right) \\ &= 0.025\ \text{W} \end{aligned}$$

Power P is $\boxed{0.025\ \text{W}}$

Step 2 of 5

(b)

Voltage V is $5\ \text{V}$

Current I is $1\ \text{mA}$

According to ohms law $V = IR$

$$V = IR$$
$$5\ \text{V} = \left(1\times10^{-3}\ \text{A}\right)R$$
$$R = \frac{5\ \text{V}}{\left(1\times10^{-3}\ \text{A}\right)}$$
$$R = 5\ \text{k}\Omega$$

Resistance R is $\boxed{5\ \text{k}\Omega}$

According to power law $P = VI$

$$\begin{aligned} P &= VI \\ &= \left(5\ \text{V}\right)\left(1\times10^{-3}\ \text{A}\right) \\ &= 0.005\ \text{W} \end{aligned}$$

Power P is $\boxed{0.005\ \text{W}}$

Step 3 of 5

(c)

Voltage V is $10\ \text{V}$

Power P is $100\ \text{mW}$

According to power law $P = VI$

$$P = VI$$
$$\left(100\times10^{-3}\ \text{W}\right) = \left(10\ \text{V}\right)I$$
$$I = \frac{\left(100\times10^{-3}\ \text{W}\right)}{\left(10\ \text{V}\right)}$$
$$I = 10\ \text{mA}$$

Current I is $\boxed{10\ \text{mA}}$

According to ohms law $V = IR$

$$V = IR$$
$$10\ \text{V} = \left(10\times10^{-3}\ \text{A}\right)\left(R\right)$$
$$R = \frac{10\ \text{V}}{\left(10\times10^{-3}\ \text{A}\right)}$$
$$R = 1\ \text{k}\Omega$$

Resistance R is $\boxed{1\ \text{k}\Omega}$

Step 4 of 5

(d)

Current I is $1\ \text{mA}$

Power P is $1\ \text{mW}$

According to power law $P = VI$

$$P = VI$$
$$\left(1\times10^{-3}\ \text{W}\right) = V\left(1\times10^{-3}\ \text{A}\right)$$
$$V = 1\ \text{V}$$

Voltage V is $\boxed{1\ \text{V}}$

According to ohms law $V = IR$

$$V = IR$$
$$1\ \text{V} = \left(1\times10^{-3}\ \text{A}\right)\left(R\right)$$
$$R = \frac{1\ \text{V}}{\left(1\times10^{-3}\ \text{A}\right)}$$
$$R = 1\ \text{k}\Omega$$

Resistance R is $\boxed{1\ \text{k}\Omega}$

Step 5 of 5

(e)

Resistance R is $1\ \text{k}\Omega$

Power P is $1\ \text{W}$

Power P is I^2R

$$P = I^2R$$
$$1\ \text{W} = I^2\left(1000\ \Omega\right)$$
$$I = \sqrt{\frac{1}{1000}}\ \text{A}$$
$$I = 0.032\ \text{A}$$

Current I is $\boxed{32\ \text{mA}}$

According to ohms law $V = IR$

$$\begin{aligned} V &= IR \\ &= \left(32\times10^{-3}\ \text{A}\right)\left(1000\ \Omega\right) \\ &= 32\ \text{V} \end{aligned}$$

Voltage V is $\boxed{32\ \text{V}}$

Step 1 of 6

Draw the circuit diagram.

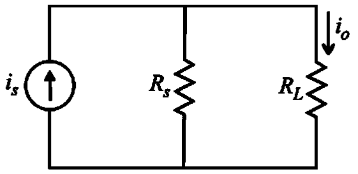

Figure 1

Step 2 of 6

Write the expression for output current using current division rule.

$$i_o = i_s\left(\frac{R_s}{R_s + R_L}\right)$$

Calculate the output voltage for $R_L = 1\ \text{k}\Omega$ by substituting 1×10^3 for R_L, 100×10^3 for R_s and 10×10^{-6} for i_s.

$$\begin{aligned} i_o &= \left(10\times10^{-6}\right)\left(\frac{100\times10^3}{100\times10^3 + 1\times10^3}\right) \\ &= \left(10\times10^{-6}\right)\left(\frac{100}{101}\right) \\ &= 9.9\ \mu\text{A} \end{aligned}$$

Therefore, the output current, i_o for $R_L = 1\ \text{k}\Omega$ is $\boxed{9.9\ \mu\text{A}}$.

Step 3 of 6

Calculate the output voltage for $R_L = 10\ \text{k}\Omega$ by substituting 10×10^3 for R_L, 100×10^3 for R_s and 10×10^{-6} for i_s in the output current expression.

$$\begin{aligned} i_o &= \left(10\times10^{-6}\right)\left(\frac{100\times10^3}{100\times10^3 + 10\times10^3}\right) \\ &= \left(10\times10^{-6}\right)\left(\frac{100}{110}\right) \\ &= 9.1\ \mu\text{A} \end{aligned}$$

Therefore, the output current, i_o for $R_L = 10\ \text{k}\Omega$ is $\boxed{9.1\ \mu\text{A}}$.

Step 4 of 6

Calculate the output voltage for $R_L = 100\ \text{k}\Omega$ by substituting 100×10^3 for R_L, 100×10^3 for R_s and 10×10^{-6} for i_s in the output current expression.

$$\begin{aligned} i_o &= \left(10\times10^{-6}\right)\left(\frac{100\times10^3}{100\times10^3 + 100\times10^3}\right) \\ &= \left(10\times10^{-6}\right)\left(\frac{100}{200}\right) \\ &= 5\ \mu\text{A} \end{aligned}$$

Therefore, the output current, i_o for $R_L = 100\ \text{k}\Omega$ is $\boxed{5\ \mu\text{A}}$.

Step 5 of 6

Calculate the output voltage for $R_L = 1\ \text{M}\Omega$ by substituting 1×10^6 for R_L, 100×10^3 for R_s and 10×10^{-6} for i_s in the output current expression.

$$\begin{aligned} i_o &= \left(10\times10^{-6}\right)\left(\frac{100\times10^3}{100\times10^3 + 1\times10^6}\right) \\ &= \left(10\times10^{-6}\right)\left(\frac{100}{1100}\right) \\ &= 0.9\ \mu\text{A} \end{aligned}$$

Therefore, the output current, i_o for $R_L = 100\ \text{k}\Omega$ is $\boxed{0.9\ \mu\text{A}}$.

Step 6 of 6

The output current is 80 % of the source current.

That is, $i_o = 0.8 i_s$.

Write the formula for output current.

$$i_o = i_s\left(\frac{R_s}{R_L + R_s}\right)$$

Substitute $100\ \text{k}\Omega$ for R_s and $0.8 i_s$ for i_o.

$$\begin{aligned} 0.8 i_s &= i_s\left(\frac{100\times10^3}{R_L + 100\times10^3}\right) \\ 0.8 &= \left(\frac{100\times10^3}{R_L + 100\times10^3}\right) \\ 0.8R_L + 80\times10^3 &= 100\times10^3 \\ 0.8R_L &= 20\times10^3 \end{aligned}$$

$$\begin{aligned} R_L &= 25\times10^3\ \Omega \\ &= 25\ \text{k}\Omega \end{aligned}$$

Therefore, the load resistance, R_L is $\boxed{25\ \text{k}\Omega}$.

Step 1 of 19

Determine different resistances with different possible combinations like parallel, series, and series-parallel.

All possible parallel combinations:

Connect all the three resistors in parallel as shown in Figure 1.

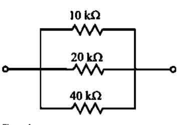

Figure 1

Step 2 of 19

Calculate the equivalent resistance.

$$R_{eq1} = (10\times10^3)\,\|\,(20\times10^3)\,\|\,(40\times10^3)$$
$$= (10\times10^3)\,\|\,(20\times10^3\,\|\,40\times10^3)$$
$$= 10\times10^3\,\|\left(\frac{(20\times10^3)(40\times10^3)}{20\times10^3+40\times10^3}\right)$$

$$= 10\times10^3\,\|\,(13.333\times10^3)$$
$$= \frac{(10\times10^3)(13.333\times10^3)}{10\times10^3+13.333\times10^3}$$
$$= \frac{133.33\times10^3}{23.333}$$
$$= 5.714\times10^3\ \Omega$$

Therefore, the equivalent resistance value is, $R_{eq1} = 5.714\,\text{k}\Omega$.

Step 3 of 19

Connect the two resistors $10\,\text{k}\Omega$ and $20\,\text{k}\Omega$ in parallel as shown in Figure 2.

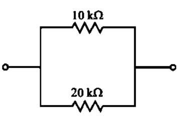

Figure 2

Step 4 of 19

Calculate the equivalent resistance.

$$R_{eq2} = (10\times10^3)\,\|\,(20\times10^3)$$
$$= \frac{(10\times10^3)(20\times10^3)}{10\times10^3+20\times10^3}$$
$$= \frac{200\times10^3}{30}$$
$$= 6.67\times10^3\ \Omega$$

Therefore, the equivalent resistance value is, $R_{eq2} = 6.67\,\text{k}\Omega$.

Step 5 of 19

Connect the two resistors $20\,\text{k}\Omega$ and $40\,\text{k}\Omega$ in parallel as shown in Figure 3.

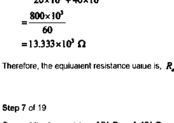

Figure 3

Step 6 of 19

Calculate the equivalent resistance

$$R_{eq3} = 20\times10^3\,\|\,40\times10^3$$
$$= \frac{(20\times10^3)(40\times10^3)}{20\times10^3+40\times10^3}$$
$$= \frac{800\times10^3}{60}$$
$$= 13.333\times10^3\ \Omega$$

Therefore, the equiuaient resistance uaiue is, $R_{eq2} = 13.333\,\text{k}\Omega$.

Step 7 of 19

Connect the two resistors $10\,\text{k}\Omega$ and $40\,\text{k}\Omega$ in parallel as shown in Figure 4.\

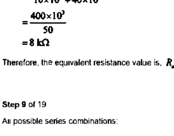

Figure 4

Step 8 of 19

Calculate the equivalent resistance.

$$R_{eq4} = (10\times10^3)\,\|\,(40\times10^3)$$
$$= \frac{(10\times10^3)(40\times10^3)}{10\times10^3+40\times10^3}$$
$$= \frac{400\times10^3}{50}$$
$$= 8\ \text{k}\Omega$$

Therefore, the equivalent resistance value is, $R_{eq4} = 8\,\text{k}\Omega$.

Step 9 of 19

All possible series combinations:

Connect the two resistors $10\,\text{k}\Omega$ and $20\,\text{k}\Omega$ are in series as shown in Figure 5.

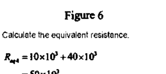

Figure 5

Calculate the equivalent resistance.

$$R_{eq5} = 10\times10^3+20\times10^3$$
$$= 30\times10^3$$

Therefore, the equivalent resistance value is, $R_{eq5} = 30\,\text{k}\Omega$.

Step 10 of 19

Connect the two resistors $10\,\text{k}\Omega$ and $40\,\text{k}\Omega$ are in series as shown in Figure 6.

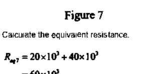

Figure 6

Calculate the equivalent resistance.

$$R_{eq4} = 10\times10^3+40\times10^3$$
$$= 50\times10^3$$

Therefore, the equivalent resistance value is, $R_{eq8} = 50\,\text{k}\Omega$.

Step 11 of 19

Connect the two resistors $20\,\text{k}\Omega$ and $40\,\text{k}\Omega$ are in series as shown in Figure 7.

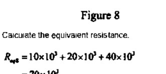

Figure 7

Calculate the equivalent resistance.

$$R_{eq7} = 20\times10^3+40\times10^3$$
$$= 60\times10^3$$

Therefore, the equivalent resistance value is, $R_{eq7} = 60\,\text{k}\Omega$.

Step 12 of 19

Connect all the three resistors in series as shown in Figure 8.

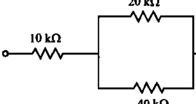

Figure 8

Calculate the equivalent resistance.

$$R_{eq8} = 10\times10^3+20\times10^3+40\times10^3$$
$$= 70\times10^3$$

Therefore, the equivalent resistance value is, $R_{eq8} = 70\,\text{k}\Omega$.

Step 13 of 19

All possible series-parallel combinations
Connect the parallel combination of $20\,\text{k}\Omega$ and $40\,\text{k}\Omega$ resistor in series with $10\ \text{k}\Omega$ resistor as shown in Figure 9

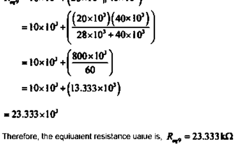

Figure 9

Step 14 of 19

Calculate the equivalent resistance.

$$R_{eq9} = 10\times10^3+(20\times10^3\,\|\,40\times10^3)$$
$$= 10\times10^3+\left(\frac{(20\times10^3)(40\times10^3)}{28\times10^3+40\times10^3}\right)$$
$$= 10\times10^3+\left(\frac{800\times10^3}{60}\right)$$
$$= 10\times10^3+(13.333\times10^3)$$

$$= 23.333\times10^3$$

Therefore, the equiuaient resistance uaiue is, $R_{eq9} = 23.333\,\text{k}\Omega$.

Step 15 of 19

Connect the parallel combination of $10\,\text{k}\Omega$ and $40\,\text{k}\Omega$ resistor in series with $20\ \text{k}\Omega$ resistor as shown in Figure 10.

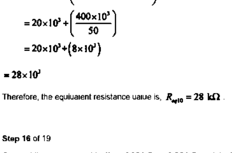

Figure 10

Calculate the equivalent resistance.

$$R_{eq10} = 20\times10^3+(10\times10^3\,\|\,40\times10^3)$$
$$= 20\times10^3+\left(\frac{(10\times10^3)(40\times10^3)}{10\times10^3+40\times10^3}\right)$$
$$= 20\times10^3+\left(\frac{400\times10^3}{50}\right)$$
$$= 20\times10^3+(8\times10^3)$$

$$= 28\times10^3$$

Therefore, the equiuaient resistance uaiue is, $R_{eq10} = 28\ \text{k}\Omega$.

Step 16 of 19

Connect the parallel combination of $10\,\text{k}\Omega$ and $20\,\text{k}\Omega$ resistor in series with $40\ \text{k}\Omega$ resistor as shown in Figure 11.

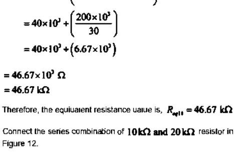

Figure 11

Calculate the equivalent resistance.

$$R_{eq11} = 40\times10^3+(10\times10^3\,\|\,20\times10^3)$$
$$= 40\times10^3+\left(\frac{(10\times10^3)(20\times10^3)}{10\times10^3+20\times10^3}\right)$$
$$= 40\times10^3+\left(\frac{200\times10^3}{30}\right)$$
$$= 40\times10^3+(6.67\times10^3)$$

$$= 46.67\times10^3\ \Omega$$
$$= 46.67\ \text{k}\Omega$$

Therefore, the equiuaient resistance uaiue is, $R_{eq11} = 46.67\ \text{k}\Omega$.

Connect the series combination of $10\,\text{k}\Omega$ and $20\,\text{k}\Omega$ resistor in parallel with $40\ \text{k}\Omega$ resistor as shown in Figure 12.

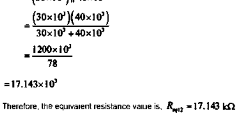

Figure 12

Step 17 of 19

Calculate the equivalent resistance.

$$R_{eq12} = (10\times10^3+20\times10^3)\,\|\,40\times10^3$$
$$= (30\times10^3)\,\|\,40\times10^3$$
$$= \frac{(30\times10^3)(40\times10^3)}{30\times10^3+40\times10^3}$$
$$= \frac{1200\times10^3}{78}$$

$$= 17.143\times10^3$$

Therefore, the equivalent resistance value is, $R_{eq12} = 17.143\ \text{k}\Omega$.

Step 18 of 19

Connect the series combination of $10\,\text{k}\Omega$ and $40\,\text{k}\Omega$ resistor in parallel with $20\ \text{k}\Omega$ resistor as shown in Figure 13.

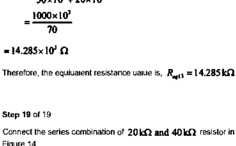

Figure 13

Calculate the equivalent resistance.

$$R_{eq13} = (10\times10^3+40\times10^3)\,\|\,20\times10^3$$
$$= (50\times10^3)\,\|\,20\times10^3$$
$$= \frac{(50\times10^3)(20\times10^3)}{50\times10^3+20\times10^3}$$
$$= \frac{1000\times10^3}{70}$$

$$= 14.285\times10^3\ \Omega$$

Therefore, the equiuaient resistance uaiue is, $R_{eq13} = 14.285\,\text{k}\Omega$.

Step 19 of 19

Connect the series combination of $20\,\text{k}\Omega$ and $40\,\text{k}\Omega$ resistor in parallel with $10\ \text{k}\Omega$ resistor as shown in Figure 14.

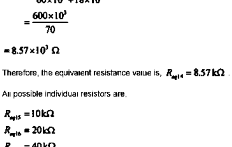

Figure 14

Calculate the equivalent resistance.

$$R_{eq14} = (20\times10^3+40\times10^3)\,\|\,10\times10^3$$
$$= (60\times10^3)\,\|\,10\times10^3$$
$$= \frac{(60\times10^3)(10\times10^3)}{60\times10^3+18\times10^3}$$
$$= \frac{600\times10^3}{70}$$

$$= 8.57\times10^3\ \Omega$$

Therefore, the equivalent resistance value is, $R_{eq14} = 8.57\,\text{k}\Omega$.

All possible individual resistors are,

$$R_{eq15} = 10\,\text{k}\Omega$$
$$R_{eq16} = 20\,\text{k}\Omega$$
$$R_{eq12} = 40\,\text{k}\Omega$$

Therefore, the total possible resistances are $\boxed{17}$.

The values from lowest values to highest values are

$$\boxed{\begin{array}{l} R_{eq1} = 5.714\,\text{k}\Omega,\ R_{eq2} = 6.67\,\text{k}\Omega,\ R_{eq4} = 8\,\text{k}\Omega,\ R_{eq14} = 8.57\,\text{k}\Omega,\ R_{eq15} = 10\,\text{k}\Omega, \\ R_{eq3} = 13.333\,\text{k}\Omega,\ R_{eq13} = 14.285\,\text{k}\Omega,\ R_{eq12} = 17.143\ \text{k}\Omega,\ R_{eq16} = 20\,\text{k}\Omega, \\ R_{eq8} = 23.333\,\text{k}\Omega,\ R_{eq10} = 28\ \text{k}\Omega,\ R_{eq5} = 30\,\text{k}\Omega,\ R_{eq12} = 40\,\text{k}\Omega,\ R_{eq11} = 46.67\ \text{k}\Omega \\ R_{eq8} = 50\,\text{k}\Omega,\ R_{eq7} = 60\,\text{k}\Omega,\ R_{eq8} = 70\,\text{k}\Omega \end{array}}$$

Step 1 of 2

The time period of the sine-wave signal is, $T = 1\,\text{ms}$.

Calculate the frequency.

$$f = \frac{1}{T}$$

Substitute $1\,\text{ms}$ for T .

$$\begin{aligned} f &= \frac{1}{1\times10^{-3}} \\ &= 1\times10^{3} \\ &= 1000\ \text{Hz} \end{aligned}$$

Therefore, the frequency, f is $\boxed{1000\ \text{Hz}}$.

Step 2 of 2

Calculate the angular frequency.

$$\omega = 2\pi f$$

Substitute $1000\,\text{Hz}$ for f .

$$\begin{aligned} \omega &= 2\pi(1000) \\ &= 2\pi(1000) \\ &= 2\pi\times10^{3}\ \text{rad/s} \end{aligned}$$

Therefore, the angular frequency, ω is $\boxed{2\pi\times10^{3}\ \text{rad/s}}$.

Step 1 of 8

The original resistor value is, $R = 10\,\text{k}\Omega$

Calculate the equivalent resistance of two parallel connected resistors.

$$R_{eq} = R \parallel R_{Shunt} = \frac{RR_{Shunt}}{R + R_{Shunt}}$$

The equivalent resistance value is reduced by 1%.

Calculate the shunt resistance value.

$$0.99(10\times10^3) = 10\times10^3 \parallel R_{Shunt}$$
$$(9.9\times10^3) = \frac{(10\times10^3)R_{Shunt}}{10\times10^3 + R_{Shunt}}$$
$$(9.9\times10^3)(10\times10^3 + R_{Shunt}) = (10\times10^3)R_{Shunt}$$
$$(9.9)(10\times10^3 + R_{Shunt}) = 10R_{Shunt}$$
$$99\times10^3 + 9.9R_{Shunt} = 10R_{Shunt}$$
$$99\times10^3 = 10R_{Shunt} - 9.9R_{Shunt}$$
$$99\times10^3 = 0.1R_{Shunt}$$
$$R_{Shunt} = \frac{99\times10^3}{0.1}$$
$$R_{Shunt} = 990\,\text{k}\Omega$$

Therefore, the value of shunt resistor, R_{Shunt} when the combined resistance is reduced by **1%**, is $\boxed{990\,\text{k}\Omega}$.

Step 2 of 8

The equivalent resistance value is reduced by 5%.

Calculate the shunt resistance value.

$$0.95(10\times10^3) = 10\times10^3 \parallel R_{Shunt}$$
$$(9.5\times10^3) = \frac{(10\times10^3)R_{Shunt}}{10\times10^3 + R_{Shunt}}$$
$$(9.5\times10^3)(10\times10^3 + R_{Shunt}) = (10\times10^3)R_{Shunt}$$
$$(9.5)(10\times10^3 + R_{Shunt}) = 10R_{Shunt}$$
$$95\times10^3 + 9.5R_{Shunt} = 10R_{Shunt}$$
$$95\times10^3 = 10R_{Shunt} - 9.5R_{Shunt}$$
$$95\times10^3 = 0.5R_{Shunt}$$
$$R_{Shunt} = \frac{95\times10^3}{0.5}\ \Omega$$
$$R_{Shunt} = 190\,\text{k}\Omega$$

Therefore, the value of shunt resistor, R_{Shunt} when the combined resistance is reduced by **5%**, is $\boxed{190\,\text{k}\Omega}$.

Step 3 of 8

The equivalent resistance value is reduced by 10%.

Calculate the shunt resistance value.

$$0.90(10\times10^3) = 10\times10^3 \parallel R_{Shunt}$$
$$(9\times10^3) = \frac{(10\times10^3)R_{Shunt}}{10\times10^3 + R_{Shunt}}$$
$$(9\times10^3)(10\times10^3 + R_{Shunt}) = (10\times10^3)R_{Shunt}$$
$$(9)(10\times10^3 + R_{Shunt}) = 10R_{Shunt}$$
$$90\times10^3 + 9R_{Shunt} = 10R_{Shunt}$$
$$90\times10^3 = 10R_{Shunt} - 9R_{Shunt}$$
$$90\times10^3 = 1R_{Shunt}$$
$$R_{Shunt} = \frac{90\times10^3}{1}\ \Omega$$
$$R_{Shunt} = 90\,\text{k}\Omega$$

Therefore, the value of shunt resistor, R_{Shunt} when the combined resistance is reduced by **10%**, is $\boxed{90\,\text{k}\Omega}$.

Step 4 of 8

The equivalent resistance value is reduced by 50%.

Calculate the shunt resistance value.

$$0.5(10\times10^3) = 10\times10^3 \parallel R_{Shunt}$$
$$(5\times10^3) = \frac{(10\times10^3)R_{Shunt}}{10\times10^3 + R_{Shunt}}$$
$$(5\times10^3)(10\times10^3 + R_{Shunt}) = (10\times10^3)R_{Shunt}$$
$$(5)(10\times10^3 + R_{Shunt}) = 10R_{Shunt}$$

Step 5 of 8

Simplify further.

$$50\times10^3 + 5R_{Shunt} = 10R_{Shunt}$$
$$50\times10^3 = 10R_{Shunt} - 5R_{Shunt}$$
$$50\times10^3 = 5R_{Shunt}$$
$$R_{Shunt} = \frac{50\times10^3}{5}\ \Omega$$
$$R_{Shunt} = 10\,\text{k}\Omega$$

Therefore, the value of shunt resistor, R_{Shunt} when the combined resistance is reduced by **10%**, is $\boxed{10\,\text{k}\Omega}$.

Step 6 of 8

Calculate the resultant resistance if $R_{Shunt} = 1\,\text{M}\Omega$.

$$R_{eq} = \frac{(10\times10^3)(1\times10^6)}{(10\times10^3) + (1\times10^6)} = \frac{(10\times10^3)(1\times10^6)}{1.01\times10^6} = \frac{10\times10^3}{1.01} = 9.9\,\text{k}\Omega$$

Therefore, the resultant resistance, R_{eq} if $R_{Shunt} = 1\,\text{M}\Omega$ is $\boxed{9.9\,\text{k}\Omega}$.

Step 7 of 8

Calculate the resultant resistance if $R_{Shunt} = 100\,\text{k}\Omega$.

$$R_{eq} = \frac{(10\times10^3)(100\times10^3)}{(10\times10^3) + (100\times10^3)} = \frac{(10\times10^3)(100\times10^3)}{110\times10^3} = \frac{100\times10^3}{11} = 9.091\,\text{k}\Omega$$

Therefore, the resultant resistance, R_{eq} if $R_{Shunt} = 100\,\text{k}\Omega$ is $\boxed{9.091\,\text{k}\Omega}$.

Step 8 of 8

If Calculate the resultant resistance if $R_{Shunt} = 10\,\text{k}\Omega$.

$$R_{eq} = \frac{(10\times10^3)(10\times10^3)}{(10\times10^3) + (10\times10^3)} = \frac{(10\times10^3)(10\times10^3)}{20\times10^3} = \frac{100\times10^3}{20} = 5\,\text{k}\Omega$$

Therefore, the resultant resistance, R_{eq} if $R_{Shunt} = 10\,\text{k}\Omega$ is $\boxed{5\,\text{k}\Omega}$.

Step 1 of 3

1.006E

(a)

The frequency of the sine wave is, $f = 60\,\text{Hz}$.

The time period is,

$$T = \frac{1}{f}$$

Substitute $60\ \text{Hz}$ for f .

$$\begin{aligned} T &= \frac{1}{60} \\ &= 16.7 \times 10^{-3}\ \text{s} \\ &= 16.7\ \text{ms} \end{aligned}$$

Therefore, the time period of the sine waveform, T is $\boxed{16.7\ \text{ms}}$.

Step 2 of 3

(b)

The frequency of the sine wave is, $f = 10^{-3}\ \text{Hz}$.

The time period is,

$$T = \frac{1}{f}$$

Substitute $10^{-3}\ \text{Hz}$ for f .

$$\begin{aligned} T &= \frac{1}{10^{-3}} \\ &= 10^{3} \\ &= 1000\ \text{s} \end{aligned}$$

Therefore, the time period of the sine waveform, T is $\boxed{1000\ \text{s}}$.

Step 3 of 3

(c)

The frequency of the sine wave is, $f = 1\ \text{MHz}$.

The time period is,

$$T = \frac{1}{f}$$

Substitute $1\ \text{MHz}$ for f .

$$\begin{aligned} T &= \frac{1}{1 \times 10^{6}} \\ &= 1 \times 10^{-6}\ \text{s} \\ &= 1\ \mu\text{s} \end{aligned}$$

Therefore, the time period of the sine waveform, T is $\boxed{1\ \mu\text{s}}$.

Step 1 of 3

Refer to Figure P1.6 in the textbook.

Draw the modified circuit of Figure P1.6.

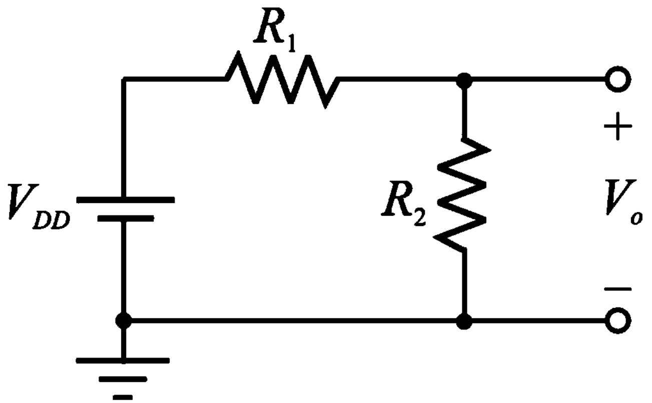

Figure 1

Step 2 of 3

Calculate the output voltage, V_o using voltage division rule.

$$V_o = \left(\frac{R_2}{R_1 + R_2}\right)(V_{DD})$$

Therefore, the output voltage, V_o is $\boxed{\left(\frac{R_2}{R_1 + R_2}\right)(V_{DD})}$.

Draw the circuit diagram, to calculate the Thevenin resistance.

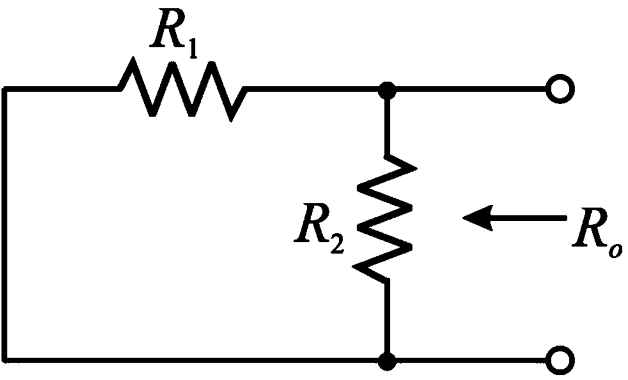

Figure 2

Step 3 of 3

From Figure 2, the equivalent output resistance is,

$$\begin{aligned} R_o &= R_1 \parallel R_2 \\ &= \frac{R_1 R_2}{R_1 + R_2} \end{aligned}$$

Therefore, the output resistance, R_o is $\boxed{\frac{R_1 R_2}{R_1 + R_2}}$.

Step 1 of 2

Ultra High Frequency range is from $470\,\text{MHz}$ to $806\,\text{MHz}$.

Starting channel is 14

Channel bandwidth, $\text{BW} = 6\,\text{MHz}$.

Calculate the number of channels.

$$N = \frac{\Delta f}{\text{BW}}$$

Substitute 6×10^6 for BW.

$$\begin{aligned} N &= \frac{806 \times 10^6 - 470 \times 10^6}{6 \times 10^6} \\ &= \frac{336 \times 10^6}{6 \times 10^6} \\ &= 56 \end{aligned}$$

Therefore, the total number of channels, N is $\boxed{56}$.

Step 2 of 2

Calculate the last channel.

$$\begin{aligned} N_{\text{Last}} &= \text{before starting channel} + \text{total number of channels} \\ &= 13 + 56 \\ &= 69 \end{aligned}$$

Therefore, the channels that can be accommodated are $\boxed{14 \text{ to } 69}$.

Step 1 of 5

1.007P

Voltage divider circuit shown in the figure 1

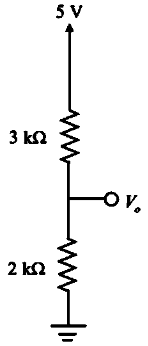

Figure 1

Step 2 of 5

Power supply voltage V_{DD} is $5\ \text{V}$

Voltage across $2\ \text{k}\Omega$ resistor is,

$$\begin{aligned} V_o &= \frac{V_{DD}}{(3+2)\ \text{k}\Omega}(2\ \text{k}\Omega) \\ &= \frac{5\ \text{V}}{(3+2)\ \text{k}\Omega}(2\ \text{k}\Omega) \\ &= 2\ \text{V} \end{aligned}$$

Output voltage V_o is $\boxed{2\ \text{V}}$

Step 3 of 5

Resistors have a manufacturing tolerance of $\pm 5\%$

Minimum value of $2\ \text{k}\Omega$ resistance is,

$$2\ \text{k}\Omega - \left(\frac{2\times 5}{100}\right)\text{k}\Omega = 1.9\ \text{k}\Omega$$

Maximum value of $2\ \text{k}\Omega$ resistance is,

$$2\ \text{k}\Omega + \left(\frac{2\times 5}{100}\right)\text{k}\Omega = 2.1\ \text{k}\Omega$$

Minimum value of $3\ \text{k}\Omega$ resistance is,

$$3\ \text{k}\Omega - \left(\frac{3\times 5}{100}\right)\text{k}\Omega = 2.85\ \text{k}\Omega$$

Maximum value of $3\ \text{k}\Omega$ resistance is,

$$2\ \text{k}\Omega + \left(\frac{2\times 5}{100}\right)\text{k}\Omega = 3.15\ \text{k}\Omega$$

Step 4 of 5

Minimum output voltages of the circuit is obtained when we use the minimum value of resistances $1.9\ \text{k}\Omega$ and maximum resistance $3.15\ \text{k}\Omega$

Voltage across $1.9\ \text{k}\Omega$ resistor is,

$$\begin{aligned} V_o &= \frac{V_{DD}}{(3.15+1.9)\ \text{k}\Omega}(1.9\ \text{k}\Omega) \\ &= \frac{5\ \text{V}}{(3.15+1.9)\ \text{k}\Omega}(1.9\ \text{k}\Omega) \\ &= 1.88\ \text{V} \end{aligned}$$

Output voltage V_o is $\boxed{1.88\ \text{V}}$

Step 5 of 5

Minimum output voltages of the circuit is obtained when we use the maximum value of resistances $2.1\ \text{k}\Omega$ and minimum value of resistance $2.85\ \text{k}\Omega$

Voltage across $2.1\ \text{k}\Omega$ resistor is,

$$\begin{aligned} V_o &= \frac{V_{DD}}{(2.85+2.1)\ \text{k}\Omega}(2.1\ \text{k}\Omega) \\ &= \frac{5\ \text{V}}{(2.85+2.1)\ \text{k}\Omega}(2.1\ \text{k}\Omega) \\ &= 2.12\ \text{V} \end{aligned}$$

Output voltage V_o is $\boxed{2.12\ \text{V}}$

Extreme output voltages of voltage divider circuit is $1.88\ \text{V}$ and $2.12\ \text{V}$

Step 1 of 6

1.008E

Refer to Figure 1.5 in the textbook for square wave signal.

The Fourier series for the signal is,

$$v(t)=\frac{4V}{\pi}\left(\sin\omega_0 t+\frac{1}{3}\sin 3\omega_0 t+\frac{1}{5}\sin 5\omega_0 t+\cdots\right)$$

Calculate the total power, P.

$$\begin{aligned}P&=\frac{1}{T}\int_0^T\frac{v^2}{R}dt\\&=\frac{1}{RT}\int_0^T(V)^2dt\\&=\frac{V^2}{RT}\int_0^T(1)dt\\&=\frac{V^2}{RT}[t]_0^T\\&=\frac{V^2}{RT}[T-0]\\&=\frac{V^2}{RT}(T)\end{aligned}$$

$P=\frac{V^2}{R}$ ...... (1)

Step 2 of 6

Calculate the total power by summing the contribution of each harmonic component.

$$\begin{aligned}P&=\frac{v^2}{R}\\&=P_1+P_3+P_5+\cdots\\&=\frac{\left(\frac{V_1}{\sqrt{2}}\right)^2}{R}+\frac{\left(\frac{V_3}{\sqrt{2}}\right)^2}{R}+\frac{\left(\frac{V_5}{\sqrt{2}}\right)^2}{R}+\cdots\\&=\frac{1}{2R}\left[\frac{4V}{\pi}\right]^2+\frac{1}{2R}\left[\frac{4V}{3\pi}\right]^2+\frac{1}{2R}\left[\frac{4V}{5\pi}\right]^2+\cdots\\&=\frac{16V^2}{2\pi^2R}\left(1+\frac{1}{9}+\frac{1}{25}+\cdots\right)\\&=\frac{V^2}{R}\left[\frac{8}{\pi^2}\left(1+\frac{1}{9}+\frac{1}{25}+\cdots\right)\right]\end{aligned}$$

Step 3 of 6

The value of $\frac{8}{\pi^2}\left(1+\frac{1}{9}+\frac{1}{25}+\cdots\right)$ is nearly equal to 1.

Consider the calculation of the infinite series in the parentheses has a sum that approaches $\frac{\pi^2}{8}$.

Therefore, the total power will be as follows:

$$P=\frac{V^2}{R}\left[\frac{8}{\pi^2}\left(\frac{\pi^2}{8}\right)\right]$$

$P=\frac{V^2}{R}$ ...... (2)

From equations (1) and (2), it is clear that the two approaches are equal.

Step 4 of 6

Calculate the fraction of energy in its fundamental.

$$\begin{aligned}E_1&=\frac{8}{\pi^2}(1)\\&=0.81\end{aligned}$$

Therefore, the fraction of energy in its fundamental, E_1 is $\boxed{0.81}$.

Calculate the fraction of energy in its first five harmonics.

$$\begin{aligned}E_5&=\frac{8}{\pi^2}\left(1+\frac{1}{9}+\frac{1}{25}\right)\\&=0.93\end{aligned}$$

Therefore, the fraction of energy in its first five harmonics, E_5 is $\boxed{0.93}$.

Step 5 of 6

Calculate the fraction of energy in its first seven harmonics.

$$\begin{aligned}E_7&=\frac{8}{\pi^2}\left(1+\frac{1}{9}+\frac{1}{25}+\frac{1}{49}\right)\\&=0.95\end{aligned}$$

Therefore, the fraction of energy in its first seven harmonics, E_7 is $\boxed{0.95}$.

Calculate the fraction of energy in its first nine harmonics.

$$\begin{aligned}E_9&=\frac{8}{\pi^2}\left(1+\frac{1}{9}+\frac{1}{25}+\frac{1}{49}+\frac{1}{81}\right)\\&=0.96\end{aligned}$$

Therefore, the fraction of energy in its first nine harmonics, E_9 is $\boxed{0.96}$.

Step 6 of 6

Calculate the fraction of energy in its first three harmonics.

$$\begin{aligned}E_3&=\frac{8}{\pi^2}\left(1+\frac{1}{9}\right)\\&=0.9\\&=90\%\end{aligned}$$

Hence, the fraction of energy in its first three harmonics, E_3 is **90%**.

Therefore, **90%** of the energy of the square wave is in the first $\boxed{3}$ harmonics.

Step 1 of 8

Each resistor value is $10\ k\Omega$

Battery voltage is $9\ V$.

(i)

Connect all the resistors in series as shown in Figure 1.

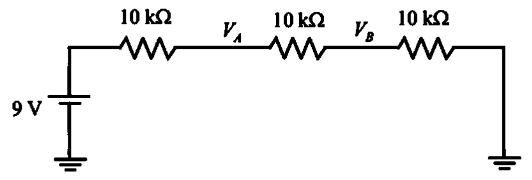

Figure 1

Step 2 of 8

Calculate the voltage, V_A using voltage divider rule.

$$V_A = \left(\frac{10\ k\Omega + 10\ k\Omega}{10\ k\Omega + 10\ k\Omega + 10\ k\Omega}\right)(9\ V)$$
$$= 6\ V$$

Calculate the equivalent output resistance.

$$R_o = (10k\Omega + 10k\Omega) \| (10k\Omega)$$
$$= 20k\Omega \| 10k\Omega$$
$$= \frac{(20k\Omega)(10k\Omega)}{20k\Omega + 10k\Omega}$$
$$= 6.667\ k\Omega$$

Therefore, the output resistance, R_o is $\boxed{6.667\ k\Omega}$.

Step 3 of 8

Calculate the voltage, V_B using voltage divider rule.

$$V_B = \left(\frac{10k\Omega}{10k\Omega + 10k\Omega + 10k\Omega}\right)(9V)$$
$$= \left(\frac{1}{3}\right)(9)$$
$$= 3\ V$$

Calculate the equivalent output resistance.

$$R_o = (10k\Omega) \| (10k\Omega + 10k\Omega)$$
$$= 20k\Omega \| 10k\Omega$$
$$= \frac{(20k\Omega)(10k\Omega)}{20k\Omega + 10k\Omega}$$
$$= 6.667\ k\Omega$$

Therefore, the output resistance, R_o is $\boxed{6.667\ k\Omega}$.

Step 4 of 8

(ii)

Draw the circuit diagram with series parallel resistors.

These are two cases,

Case (a):

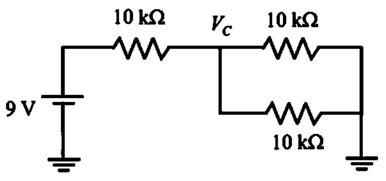

Figure 2

Step 5 of 8

Calculate the voltage, V_C using voltage divider rule.

$$V_C = \left(\frac{10k\Omega \| 10k\Omega}{10k\Omega + (10k\Omega \| 10k\Omega)}\right)(9V)$$
$$= \left(\frac{5\ k\Omega}{10\ k\Omega + 5\ k\Omega}\right)(9V)$$
$$= \left(\frac{5\ k\Omega}{15\ k\Omega}\right)(9)$$
$$= 3\ V$$

Calculate the equivalent output resistance.

$$R_o = (10k\Omega) \| (10k\Omega \| 10k\Omega)$$
$$= (10k\Omega) \| \left(\frac{(10k\Omega)(5k\Omega)}{10k\Omega + 5k\Omega}\right)$$
$$= (10k\Omega) \| (5k\Omega)$$
$$= \frac{(10k\Omega)(5k\Omega)}{10k\Omega + 5k\Omega}$$
$$= 3.333\ k\Omega$$

Therefore, the output resistance, R_o is $\boxed{3.333\ k\Omega}$.

Step 6 of 8

Case (b):
Draw the circuit diagram with series parallel resistors.

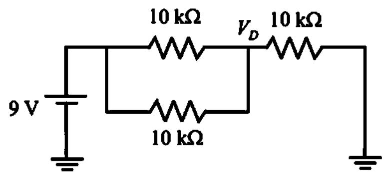

Figure 3

Step 7 of 8

Calculate the voltage, V_D using voltage divider rule.

$$V_D = \left(\frac{10k\Omega}{10k\Omega + (10k\Omega \| 10k\Omega)}\right)(9V)$$
$$= \left(\frac{10k\Omega}{10k\Omega + \left(\frac{10k\Omega \times 10k\Omega}{10k\Omega + 10k\Omega}\right)}\right)(9V)$$
$$= \left(\frac{10k\Omega}{10k\Omega + 5\ k\Omega}\right)(9V)$$
$$= \left(\frac{10k\Omega}{15k\Omega}\right)(9V)$$
$$= 6\ V$$

Calculate the equivalent output resistance.

$$R_o = (10k\Omega \| 10k\Omega) \| (10k\Omega)$$
$$= \left(\frac{10k\Omega \times 10k\Omega}{10k\Omega + 10k\Omega}\right) \| (10k\Omega)$$
$$= 5k\Omega \| 10k\Omega$$
$$= \frac{(10k\Omega)(5k\Omega)}{10k\Omega + 5k\Omega}$$
$$= 3.333\ k\Omega$$

Therefore, the output resistance, R_o is $\boxed{3.333\ k\Omega}$.

Step 8 of 8

(iii)

Connect two resistors in series as shown in Figure 4.

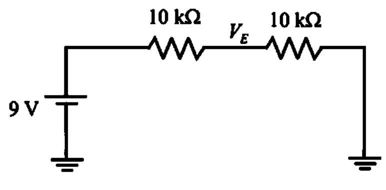

Figure 4

Calculate the voltage, V_E using voltage divider rule.

$$V_E = \left(\frac{10k\Omega}{10k\Omega + 10k\Omega}\right)(9V)$$
$$= \left(\frac{10k\Omega}{20k\Omega}\right)(9V)$$
$$= 4.5\ V$$

Calculate the equivalent output resistance.

$$R_o = (10k\Omega \| 10k\Omega)$$
$$= \frac{(10k\Omega)(10k\Omega)}{10k\Omega + 10k\Omega}$$
$$= 5k\Omega$$

Therefore, the output resistance, R_o is $\boxed{5\ k\Omega}$.

Therefore, the list of positive sources are $\boxed{3V, 4.5V \text{ and } 6V}$.

For generating $3V$ and $6V$, the case (ii) is better than case (i), because it has low output resistance.