Chapter 26, problem 8

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Test Bank Question preview

Question

A power plant tracks power usage based on the decibel level referenced to 1 kW. From Friday to Sunday, the total power usage at peak demand is 12 MW, 13 MW, and 11 MW for each respective day. Most nearly, what is the average decibel level for the weekend?

Answers

(A) 1.1 dB

(B) 11 dB

(C) 41 dB

(D) 82 dB

The answer is (C).

Solution

The average power usage for the weekend is

$$
\begin{aligned}
P &= \frac{P_t}{N_{\text{days}}} \\
&= \frac{12\ \text{MW} + 13\ \text{MW} + 11\ \text{MW}}{3} \\
&= 12\ \text{MW}
\end{aligned}
$$

From Eq. 26.14, the decibel level is

$$
\begin{aligned}
\text{ratio (in dB)} &= 10 \log_{10} \frac{P}{P_0} \\
&= 10 \log_{10} \frac{12 \times 10^6\ \text{W}}{1 \times 10^3\ \text{W}} \\
&= \boxed{40.79\ \text{W} \quad (41\ \text{dB})}
\end{aligned}
$$

QUESTION DATA

Vendor

0000059312

Solving Time

Difficulty

easy

Quantitative?

No

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Active

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Chapter 27, problem 13

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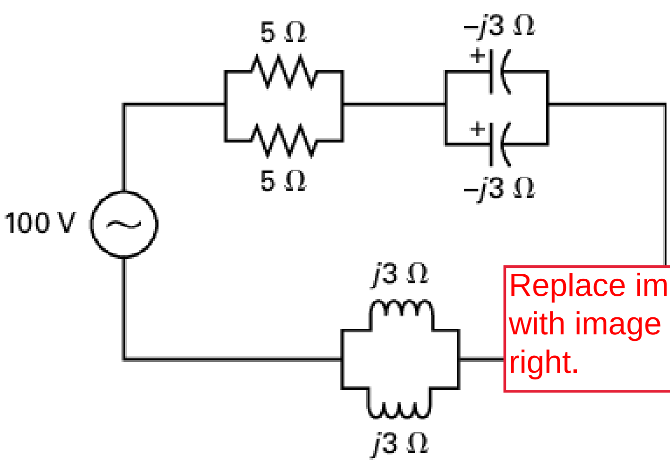
Test Bank

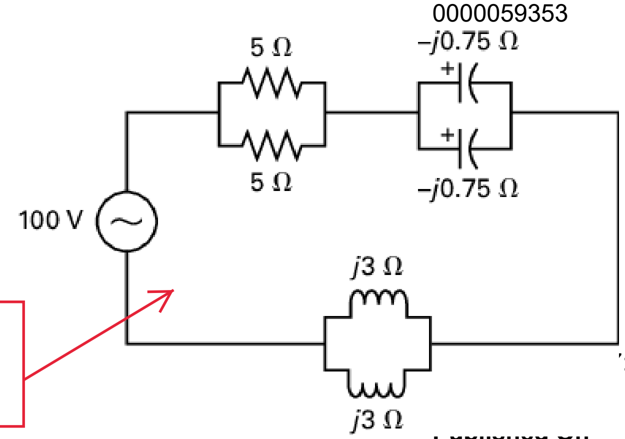
Question preview

Question

What is most nearly the power dissipated by the circuit shown?



Replace image with image on the right.



Answers

(A) 50 W

(B) 400 W

(C) 900 W

(D) 4000 W

The answer is (D).

QUESTION DATA

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Solution

Combine the parallel resistors.

$$
\begin{aligned}
\mathbf{Z}_R &= \frac{\mathbf{Z}_{5\,\Omega}\mathbf{Z}_{5\,\Omega}}{\mathbf{Z}_{5\,\Omega}+\mathbf{Z}_{5\,\Omega}} \\
&= \frac{(5\,\Omega\angle 0^\circ)(5\,\Omega\angle 0^\circ)}{5\,\Omega\angle 0^\circ + 5\,\Omega\angle 0^\circ} \\
&= 2.5\,\Omega\angle 0^\circ
\end{aligned}
$$

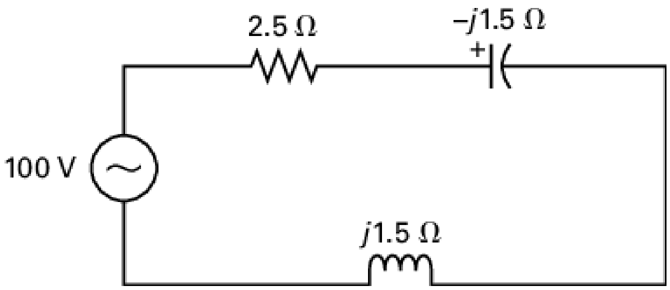
Combine the parallel capacitors.

$$\begin{aligned}\mathbf{Z}_C &= \frac{(-j3\ \Omega)(-j3\ \Omega)}{(-j3\ \Omega)+(-j3\ \Omega)} \\ &= \frac{j^2 9\ \Omega}{-j6\ \Omega} \\ &= -j1.5\ \Omega\end{aligned}$$

Combine the parallel inductors.

$$\begin{aligned}\mathbf{Z}_L &= \frac{\mathbf{Z}_{3\ \Omega}\mathbf{Z}_{3\ \Omega}}{\mathbf{Z}_{3\ \Omega}+\mathbf{Z}_{3\ \Omega}} \\ &= \frac{(j3\ \Omega)(j3\ \Omega)}{j3\ \Omega + j3\ \Omega} \\ &= j1.5\ \Omega\end{aligned}$$

The circuit can then be reduced to the equivalent circuit shown.



Calculate the total impedance of the circuit.

$$\begin{aligned}\mathbf{Z}_t &= \mathbf{Z}_R + \mathbf{Z}_C + \mathbf{Z}_L \\ &= 2.5\ \Omega\angle 0^\circ - j1.5\ \Omega\ + j1.5\ \Omega \\ &= 2.5\ \Omega\angle 0^\circ\end{aligned}$$

From Ohm's Law Eq. 27.41, the total current in the circuit is

$$\begin{aligned}\mathbf{V} &= \mathbf{IZ} \\ \mathbf{I} &= \frac{\mathbf{V}}{\mathbf{Z}} \\ &= \frac{100\ \mathrm{V}\angle 0^\circ}{2.5\ \Omega\angle 0^\circ} \\ &= 40\ \mathrm{A}\angle 0^\circ\end{aligned}$$

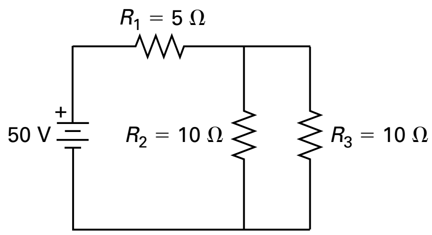
Calculate the power dissipated in the resistor only. From Eq. 29.6, the dissipated power is

$$\begin{aligned}P &= I^2 R \\ &= (40\ \mathrm{A})^2 (2.5\ \Omega) \\ &= 4000\ \mathrm{W}\end{aligned}$$

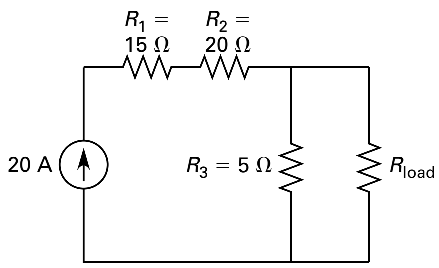
26 DC Circuit Fundamentals

PRACTICE PROBLEMS

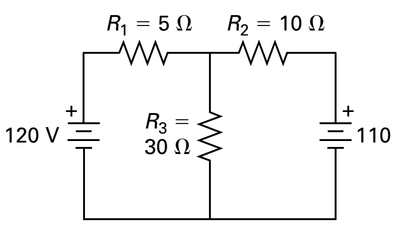
1. What is the power dissipated in R_3 of the circuit shown?



2. For the circuit shown, what resistance will result in the maximum power transfer?



3. For the circuit shown, which method will result in fewer equations: the loop-current method or the node-voltage method?



4. Using the loop-current method, solve for the current in R_3 in Prob. 3.

5. Using the node-voltage method, solve for the current in R_3 in Prob. 3.

6. 150 m of wire with a resistivity of 1.72×10^{-8} Ω·m and a diameter of 0.5 mm is used in a project. Most nearly, what is the DC voltage drop across this wire in a 15 A circuit?

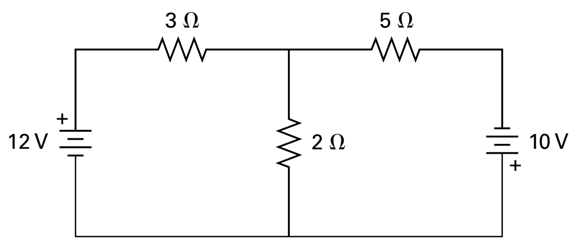
(A) 13 V

(B) 15 V

(C) 20 V

(D) 200 V

7. Most nearly, what is the power dissipated in the 2 Ω resistor of the circuit shown?



(A) 1 W

(B) 2 W

(C) 4 W

(D) 5 W

8. A power plant tracks power usage based on the decibel level referenced to 1 kW. From Friday to Sunday, the total power usage at peak demand is 12 MW, 13 MW, and 11 MW for each respective day. Most nearly, what is the average decibel level for the weekend?

(A) 1.1 dB

(B) 11 dB

(C) 41 dB

(D) 82 dB

Writing KCL for node A gives

$$\frac{V_A - 120\ \text{V}}{R_1} + \frac{V_A - 0\ \text{V}}{R_3} + \frac{V_A - 110\ \text{V}}{R_2} = 0$$

Solve for V_A.

$$\frac{V_A}{R_1} - \frac{120\ \text{V}}{R_1} + \frac{V_A}{R_3} + \frac{V_A}{R_2} - \frac{110\ \text{V}}{R_2} = 0$$

$$\frac{V_A}{R_1} + \frac{V_A}{R_3} + \frac{V_A}{R_2} = \frac{120\ \text{V}}{R_1} + \frac{110\ \text{V}}{R_2}$$

$$\begin{aligned} V_A &= \frac{\frac{120\ \text{V}}{R_1} + \frac{110\ \text{V}}{R_2}}{\frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{R_2}} \\ &= \frac{\frac{120\ \text{V}}{5\ \Omega} + \frac{110\ \text{V}}{10\ \Omega}}{\frac{1}{5\ \Omega} + \frac{1}{30\ \Omega} + \frac{1}{10\ \Omega}} \\ &= 105\ \text{V} \end{aligned}$$

Use V_A to determine the desired current.

$$I_3 = \frac{V_A}{R_3} = \frac{105\ \text{V}}{30\ \Omega} = \boxed{3.5\ \text{A}}$$

6. The resistance of the wire is calculated from Eq. 16.1.

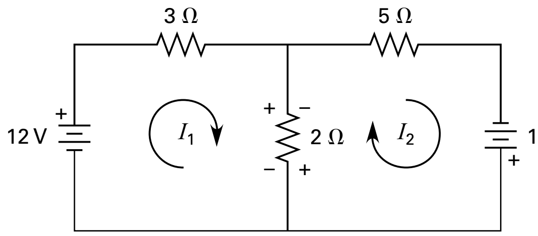
$$\begin{aligned} R &= \frac{\rho l}{A} = \frac{\rho l}{\pi\left(\frac{d}{2}\right)^2} \\ &= \frac{(1.72 \times 10^{-8}\ \Omega\cdot\text{m})(150\ \text{m})}{\pi\left(\frac{0.5 \times 10^{-3}\ \text{m}}{2}\right)^2} \\ &= 13.14\ \Omega \end{aligned}$$

From Eq. 16.1, Ohm's law, the voltage drop is

$$\begin{aligned} V &= IR \\ &= (15\ \text{A})(13.14\ \Omega) \\ &= \boxed{197.10\ \text{V}\quad (200\ \text{V})} \end{aligned}$$

The answer is (D).

7. Apply Kirchhoff's voltage law (KVL) around each loop as shown.



KVL for loop 1 is

$$12\ \text{V} - I_1R_{3\ \Omega} - I_1R_{2\ \Omega} + I_2R_{2\ \Omega} = 0$$

Rearranging the equation for KVL for loop 1 gives

$$\begin{aligned} 12\ \text{V} &= I_1(R_{2\ \Omega} + R_{3\ \Omega}) + I_2R_{2\ \Omega} \\ 12\ \text{V} &= I_1(5\ \Omega) + I_2(2\ \Omega) \end{aligned}$$

KVL for loop 2 is

$$10\ \text{V} - I_2R_{2\ \Omega} + I_1R_{2\ \Omega} - I_2R_{5\ \Omega} = 0$$

Rearranging the equation for KVL for loop 2 gives

$$\begin{aligned} &10\ \text{V} - I_1R_{2\ \Omega} + I_2(R_{2\ \Omega} + R_{5\ \Omega}) \\ &10\ \text{V} - I_1(2\ \Omega) + I_2(7\ \Omega) \end{aligned}$$

For loop 1, from Cramer's rule and matrix algebra, the current is

$$\begin{aligned} I_1 &= \frac{|\mathbf{A_1}|}{|\mathbf{A}|} = \frac{\begin{vmatrix} 12\ \text{V} & 2\ \Omega \\ 10\ \text{V} & 7\ \Omega \end{vmatrix}}{\begin{vmatrix} 5\ \Omega & -2\ \Omega \\ -2\ \Omega & 7\ \Omega \end{vmatrix}} \\ &= \frac{(12\ \text{V})(7\ \Omega) - (10\ \text{V})(-2\ \Omega)}{(5\ \Omega)(7\ \Omega) - (-2\ \Omega)(-2\ \Omega)} \\ &= 3.354\ \text{A} \end{aligned}$$

For loop 2, from Cramer's rule and matrix algebra, the current is

$$\begin{aligned} I_2 &= \frac{|\mathbf{A}_2|}{|\mathbf{A}|} = \frac{\begin{vmatrix} 5\ \Omega & 12\ \text{V} \\ -2\ \Omega & 10\ \text{V} \end{vmatrix}}{\begin{vmatrix} 5\ \Omega & 2\ \Omega \\ -2\ \Omega & 7\ \Omega \end{vmatrix}} \\ &= \frac{(5\ \Omega)(10\ \text{V}) - (-2\ \Omega)(12\ \text{V})}{(5\ \Omega)(7\ \Omega) - (-2\ \Omega)(-2\ \Omega)} \\ &= 2.387\ \text{A} \end{aligned}$$

The actual current through the 2 Ω resistor is the

Circuit Theory

combination of the two currents, using the directions assumed. The sign of the result determines the correct direction of the current.

$$\begin{aligned} I_{2\,\Omega} &= I_1 - I_2 \\ &= 3.354\ \text{A} - 2.387\ \text{A} \\ &= 0.967\ \text{A} \end{aligned}$$

From Eq. 16.1, the power dissipated in the 2 Ω resistor is

$$\begin{aligned} P &= I^2R = I_{2\,\Omega}^2 R_{2\,\Omega} \\ &= (0.967\ \text{A})^2(2\ \Omega) \\ &= \boxed{1.87\ \text{W} \quad (2\ \text{W})} \end{aligned}$$

The answer is (B).

8. The average power usage for the weekend is

$$\begin{aligned} P &= \frac{P_t}{N_{\text{days}}} \\ &= \frac{12\ \text{MW} + 13\ \text{MW} + 11\ \text{MW}}{3} \\ &= 12\ \text{MW} \end{aligned}$$

From Eq. 16.1, the decibel level is

$$\begin{aligned} \text{ratio (in dB)} &= 10\log_{10}\frac{P}{P_0} \\ &= 10\log_{10}\frac{12\times 10^6\ \text{W}}{1\times 10^3\ \text{W}} \\ &= \boxed{40.79\ \text{dB} \quad (41\ \text{dB})} \end{aligned}$$

The answer is (C).

9. The voltage regulation is given by Eq. 16.1.

$$\text{VR} = \frac{V_{\text{nl}} - V_{\text{fl}}}{V_{\text{fl}}} \times 100\%$$

Equation 16.1 is rearranged in order to find the generator's full load voltage.

$$\begin{aligned} V_{\text{fl}} &= \frac{V_{\text{nl}}}{\frac{\text{VR}}{100\%} + 1} = \frac{250\ \text{V}}{\frac{3\%}{100\%} + 1} \\ &= \boxed{242.7\ \text{V} \quad (240\ \text{V})} \end{aligned}$$

The answer is (B).

10. Use Millman's theorem. The two voltage sources in parallel, V_1 and V_2, can be combined into a single voltage source of 12 V. This 12 V source is in series with V_3. The resistor does not have an impact until the current flows (i.e., until a load is added). Sum the voltages to find the total voltage in the circuit.

$$\begin{aligned} V_t &= V_{1,2} + V_3 \\ &= 12\ \text{V} + 3\ \text{V} \\ &= \boxed{15\ \text{V}} \end{aligned}$$

The answer is (C).

11. The two circuits are equivalent if the voltages at the terminals and the resistance as seen from the terminals are identical in each circuit.

Determine the source current by shorting terminals A and B and applying Ohm's law, Eq. 16.1.

$$\begin{aligned} V_s &= I_s R_{\text{int}} \\ I_s &= \frac{V_s}{R_{\text{int}}} \\ &= \frac{4\ \text{V}}{0.75\ \Omega} \\ &= \boxed{5.33\ \text{A} \quad (5.3\ \text{A})} \end{aligned}$$

The resistance is found from Ohm's law. The voltage across R_I must be 4 V.

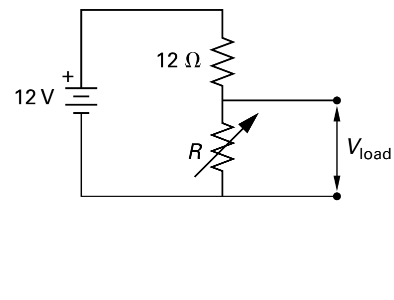
$$\begin{aligned} V_{\text{AB}} &= V_{\text{terminal}} = V_s \\ &= I_s R_I \\ R_I &= \frac{V_s}{I_s} = \frac{4\ \text{V}}{5.33\ \text{A}} \\ &= \boxed{0.75\ \Omega} \end{aligned}$$

The answer is (A).

12. Resistors A, B, and C are in series. The total resistance for the three resistors is

$$\begin{aligned} R_{\text{series}} &= R_{\text{A}} + R_{\text{B}} + R_{\text{C}} \\ &= 2\ \Omega + 4\ \Omega + 6\ \Omega \\ &= 12\ \Omega \end{aligned}$$

The equivalent circuit is shown.



Circuit Theory

Chapter 56, problem 28

Test Bank Question preview

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Question

A garage is set up to charge two electric vehicles on a 20 A, single-phase branch circuit supplied with 208 V. What is the total minimum ventilation requirement in such a system?

Answers

(A) 37 cfm

(B) 49 cfm

(C) 85 cfm

(D) 170 cfm

The answer is (D).

Solution

Electric vehicle charging systems are covered in NEC Art. 625, and the ventilation requirements in cubic feet per minute (cfm) are found in Table ~~652~~ 52(B)(1)(b). The table lists the values of ventilation required for a single vehicle. For a 20 A, single-phase branch circuit at 208 V, the requirement listed is 85 cfm. For two vehicles, the total minimum ventilation required is 2×85 cfm $= \boxed{170 \text{ cm.}}$

QUESTION DATA

Vendor

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Solving Time

Difficulty

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Quantitative?

No

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