1995 Electrical Engineering Qualifying Examination Questions

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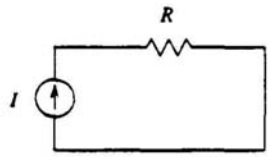
Consider the following electrical circuit.



1. What is the voltage drop across the resistor?

   ANSWER: $V = IR$

2. Suppose that the resistor is a random variable $\tilde{R}$ with uniformly distributed in the range $R \pm \Delta R$. What is the expected value of the voltage drop?

   ANSWER: $E[V] = E[I\tilde{R}] = IE[\tilde{R}] = IR$

3. Suppose that the current source is also a random variable $\tilde{I}$. What is the expected value of the voltage drop.

   EXPECTED QUESTIONS: Are $\tilde{I}$ and $\tilde{R}$ independent? What is the joint probability distribution of $\tilde{I}$ and $\tilde{R}$.

   ANSWER: If $\tilde{I}$ and $\tilde{R}$ are independent, then $E[V] = E[\tilde{I}\tilde{R}] = E[\tilde{I}]E[\tilde{R}] = IR$, where $I = E[\tilde{I}]$.

4. What is a weaker condition than independence that guarantees that $E[\tilde{I}\tilde{R}] = IR$?

   ANSWER: Uncorrelated.

5. Suppose that two random resistors $\tilde{R}_1$ and $\tilde{R}_2$ are connected in series. What is the average resistance?

   ANSWER: $E[\tilde{R}_1 + \tilde{R}_2] = E[\tilde{R}_1 + \tilde{R}_2] = 2R$

6. What if the resistors values are not statistically independent?

   ANSWER: The expected value of a sum is always the sum of the expected values.

7. Suppose that two random resistors $\tilde{R}_1$ and $\tilde{R}_2$ are connected in parallel. What is the average resistance?

   EXPECTED QUESTION: What is the joint probability distribution of $\tilde{R}_1$ and $\tilde{R}_2$? Suppose the resistors are independent.