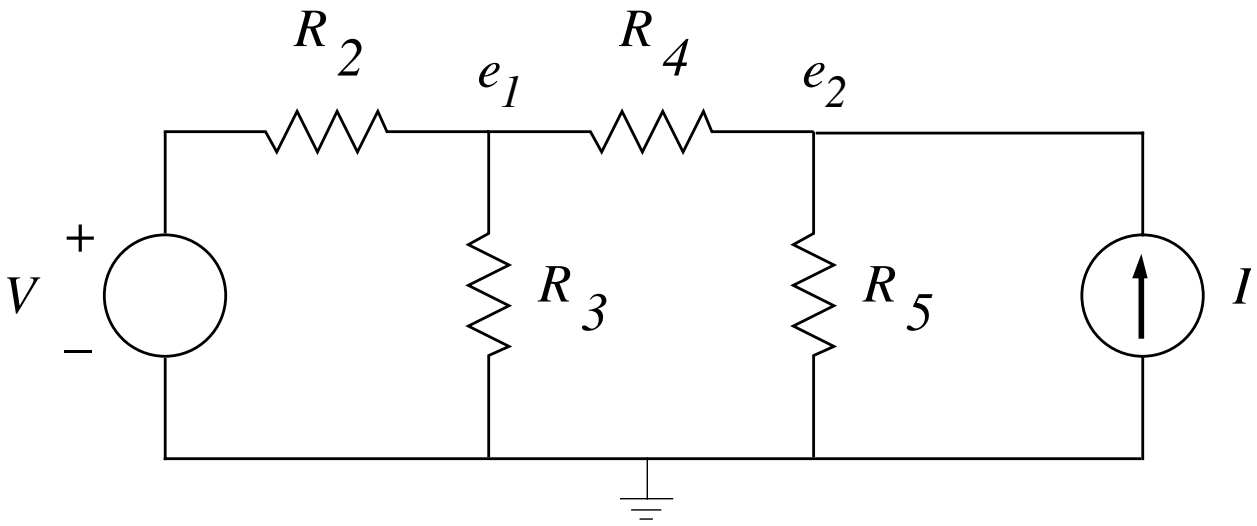
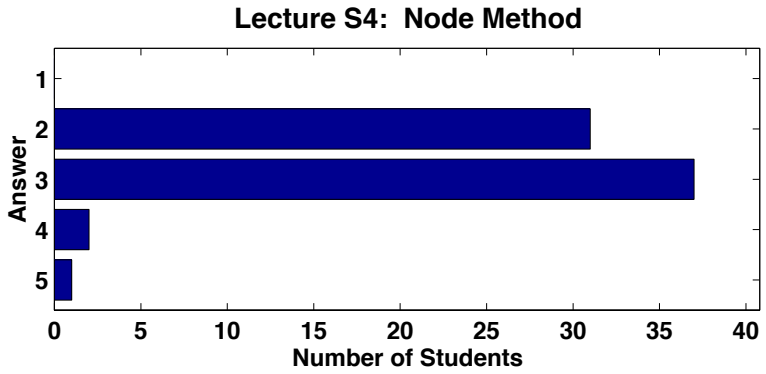
Node Method
Concept Test

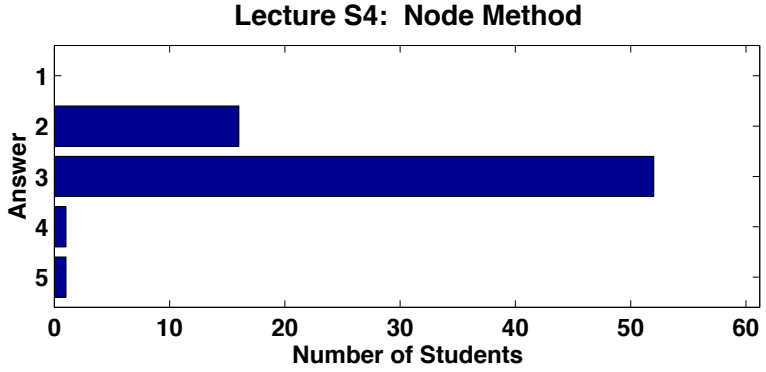


For the network above, find the equation that expresses Kirchhoff's Current Law at the node e_2. My answer was

1. $(R_4 + R_5)e_2 - R_4 e_1 = -I$
2. $(G_4 + G_5)e_2 - G_4 e_1 = -I$
3. $(G_4 + G_5)e_2 - G_4 e_1 = I$
4. **Not among the answers above**
5. **I was unable to get an answer**

Node Method Solution



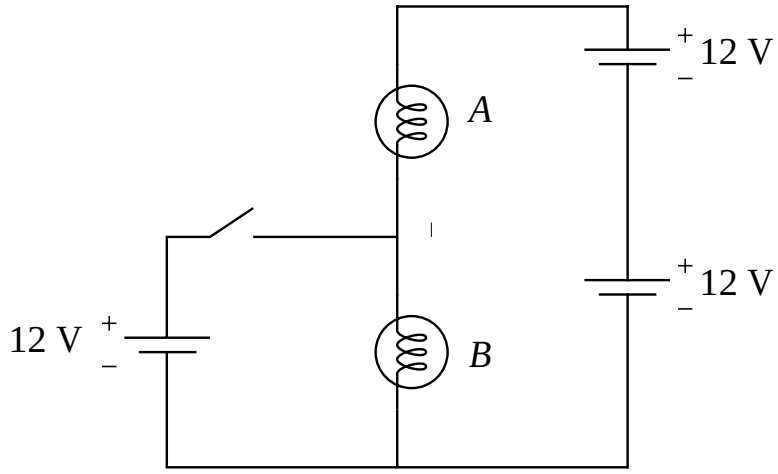


The correct answer is #3. The current flowing out of the node through R_4 is $(e_2 - e_1)/R_4 = G_4(e_2 - e_1)$. The current flowing out of the node through R_5 is $(e_2 - 0)/R_5 = G_5 e_2$. The current flowing out of the node through the current source is $-I$, because the source points into the node. So

$$(G_4 + G_5)e_2 - G_4 e_1 - I = 0$$

The class did significantly better on the second try, when I asked everyone to find someone who disagrees with them, and to try to come to a consensus on the answer.

Light Bulb I
Concept Test

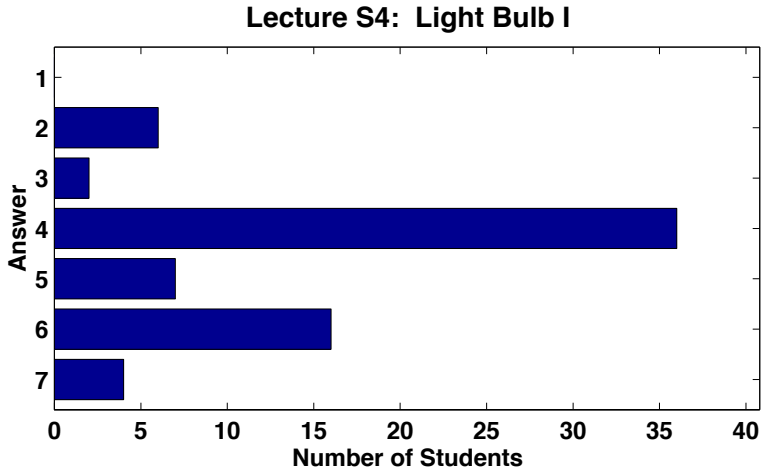


The light bulbs in the circuit are identical. When the switch is closed,

1. **Both bulbs go out**
2. **The intensity of light bulb *A* increases.**
3. **The intensity of light bulb *A* decreases.**
4. **The intensity of light bulb *B* increases.**
5. **The intensity of light bulb *B* decreases.**
6. **Some combination of 1–5 occurs.**
7. **Nothing happens**

Concept test due to Eric Mazur, Harvard.

Light Bulb I
Solution



We designate the bottom node as ground, and hence its voltage is zero. The node above the lower battery on the right is 12 V above zero, and hence is 12 V. The node above the upper battery on the right is 12 V above that, and hence is 24 V. With the switch open, the two bulbs form a voltage divider. Because the same amount of current flows through the two identical bulbs, the voltage drop across each is the same. Because the drop across two bulbs is 24 V, the drop across each bulb must be 12 V. So the potential of the node between the two bulbs is 12 V, again, before the switch is closed.

After the switch is closed, the potential of the node between the bulbs must be 12 V, since now the battery (almost a voltage source) fixes the potential. But it was 12 V before the switch closed! So closing the switch doesn't really change anything, and the light bulb intensities don't change. Therefore, the correct answer is #7.

Surprising, there were only 4 students with the correct answer. The concept test measures your conceptual understanding of node potentials, so some work is needed in this area.