University Electrical Engineering Name: _____ Score: _____

1. A 3.7 V battery stores 3 A · h of charge. Which energy value is correct?

   ☐ 3.7 J

   ☐ About 4.0×10^7 J

   ☐ About 4.0×10^4 J

   ☐ 11.1 J

2. At a node, 4 A and 1.5 A flow in, and 2 A flows out through a third branch. What does KCL give for the fourth branch?

   ☐ 3.5 A flowing in

   ☐ 0.5 A flowing out

   ☐ 3.5 A flowing out

   ☐ 7.5 A flowing out

3. A 12 V source feeds a node through 4 Ω; a 6 Ω runs from the node to ground. What is the node voltage?

   ☐ 6.0 V

   ☐ 9.6 V

   ☐ 12 V

   ☐ 7.2 V

4. A 10 V source feeds 5 Ω in series with a 20 Ω shunt. What are V_th and R_th at the shunt terminals?

   ☐ 2 V and 4 Ω

   ☐ 8 V and 25 Ω

   ☐ 8 V and 4 Ω

   ☐ 10 V and 4 Ω

5. The virtual-short rule says the two input voltages are equal. Why?

   ☐ Input resistance is zero

   ☐ It only holds without feedback

   ☐ Infinite gain with negative feedback forces the input difference toward zero

   ☐ The inputs are physically connected inside

6. The voltage on a 10 µF capacitor rises steadily at 100 V per second. What current flows, in mA?

   _____ mA

7. A capacitor at 1 V is switched onto a 5 V supply through a resistor, with $\tau = 2$ s. What is its voltage after 2 s, in volts? Give two decimal places.

   _____ V

8. The 12 V, 0.25 A lamp stays on for 5 minutes. How much energy does it take, in joules?

   _____ J

9. A 12 V supply is connected across a 2.4 kΩ resistor. What current flows, in mA?

   _____ mA

10. A 4 V source joins P (+) to Q. Both P and Q have 4 Ω to ground, and 2 A is injected into P. What is V_Q, in volts?

    _____ V

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1. **About 4.0 × 10^4 J**

   3 A · h at 3.7 V gives 11.1 W · h; 11.1 × 3600 ≈ 4.0 × 10^4 J. The megajoule option forgets the hours-to-seconds step.

2. **3.5 A flowing out**

   Signed sum out = 0 gives −4 − 1.5 + 2 + i_4 = 0, so i_4 = 3.5 A out. Nothing is consumed at the node.

3. **7.2 V**

   The divider 12 × 6/(4+6) = 7.2 V equals the nodal answer; both branch currents then equal 1.2 A.

4. **8 V and 4 Ω**

   V_th = 10 × 20/25 = 8 V; with the source shorted, R_th = 5 ∥ 20 = 4 Ω. Adding the series resistor to R_th is the classic slip.

5. **Infinite gain with negative feedback forces the input difference toward zero**

   The output can only stay inside the rails if the fed-back difference is essentially zero - A × (v+ − v−) finite with A → ∞ requires v+ ≈ v−.

6. **1 mA**

   $i = C\frac{dv}{dt} = 10 \times 10^{-6} \times 100 = 0.001\,\text{A} = 1\,\text{mA}$, constant because the slope is constant.

7. **3.53 V**

   $v = 5 + (1-5)e^{-1} = 5 - 4 \times 0.368 \approx 3.53\,\text{V}$. One time constant closes 63% of the 4 V gap.

8. **900 J**

   $p = 12 \times 0.25 = 3\,\text{W}$, and $w = pt = 3 \times 300 = 900\,\text{J}$. Convert the minutes to seconds first.

9. **5 mA**

   $i = \frac{v}{R} = \frac{12}{2400} = 0.005\,\text{A} = 5\,\text{mA}$.

10. **2 V**

    Supernode: $\frac{V_P}{4} + \frac{V_Q}{4} = 2$, so $V_P + V_Q = 8$; with $V_P - V_Q = 4$ this gives $V_P = 6\,\text{V}$ and $V_Q = 2\,\text{V}$.