

task_w3wf215v2u98ty07_with_calculation

Student Group

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efficiency, charges, power, exam ee1 SS2023

Exercise E9 Efficiency

(written test, approx. 14 % of a 60-minute written test, SS2023)

8. (14.00 Points) On the left, a battery with an electromotive force $\mathcal{E}$ and an internal resistance R_i is connected to a load resistor R_L . The battery shall provide energy for a device with an load resistance of $R_L = 2 + 10 \Omega$. The following values are from the battery data sheet.

begin{align*} \mathcal{E} &= 3.5 \text{ V} \\ R_i &= 0.05 \Omega \\ I_{\text{Dis max}} &= 3.5 \text{ A} \end{align*}

Solution: (14.00 Points) With the relation $R_L = R_i + R_{\text{ext}}$ we have $R_{\text{ext}} = R_L - R_i = 2 \Omega$.

• Verify: $\mathcal{E} = 3.5 \text{ V}$, $R_i = 0.05 \Omega$, $I_{\text{Dis max}} = 3.5 \text{ A}$

lowest efficiency for highest load resistance for $R_L = R_i + R_{\text{ext}}$ in this case, the

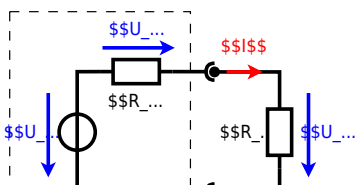
.. Draw an equivalent circuit diagram with the internal resistance and an external load.

begin{align*} \eta &= \frac{P_{\text{out}}}{P_{\text{in}}} = \frac{I^2 R_L}{I^2 (R_i + R_L)} = \frac{R_L}{R_i + R_L} = \frac{2}{0.05 + 2} = 0.976 \end{align*}

begin{align*} \eta &= \frac{U_{\text{out}} I}{\mathcal{E} I} = \frac{U_{\text{out}}}{\mathcal{E}} = \frac{2}{3.5} = 0.571 \end{align*}

$\eta = 1 - \frac{R_i}{R_i + R_L} = 1 - \frac{0.05}{2.05} = 0.976$

Result: $\eta = 0.976$



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