task_unkkahm3u0v9azny_with_calculation

Student Group

First Name	Surname	Matrikel Nr.

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Exercise E11 Self Induction
(written test, approx. 8 % of a 120-minute written test, SS2022)

A DC voltage source with an inductor and a circuit breaker.

Sketch the diagram of the circuit which is fused with a circuit breaker.

Determine the maximum voltage on the circuit breaker if the current is reduced linearly down to $0 ~\rm A$ within $1 ~\rm \mu s$.

The inner resistance of the motor shall be neglected.)

$u_{\rm ind} (t) = 3150 ~\rm V$

Path

1. Draw the circuit (the circuit breaker can be drawn as a switch), with all voltage and current arrows.

Result

For the maximum voltage on the circuit breaker one has to consider the following:

- external voltage of the voltage source $U_\rm s$
- voltage $u_{\rm ind} (t)$ induced by the change of the current

The first one is not given in the exercise, and therefore not considered here.

The induced voltage can be calculated by linearizing the following: \begin{align*} u_{\rm ind} (t) &= - L {{ {\rm d} i}\over{ {\rm d} t }}\\ \rightarrow u_{\rm ind} (t) &= - L {{ \Delta i}\over{ \Delta t }}\\ \end{align*}

With the given details: \begin{align*} u_{\rm ind} (t) &= - L {{ 0 - I}\over{ t_1 - t_0 }}\\ &= 50 \cdot 10^{-6} {~\rm H} {{ 63 ~\rm A}\over{ 1 \cdot 10^{-6} ~\rm s}}\\ &= 3150 {{ ~\rm Vs}\over{ ~\rm A}} \; {{ ~\rm A}\over{ ~\rm s}}\\ \end{align*}