Tutorial Sheet 4
KiBaM

Hint: These exercises were created by the tutors for the tutorials. They are neither relevant nor irrelevant for the exam. The evaluation of the difficulty corresponds to the assessment of the tutors.

Exercise T4.1 *(Recall the KiBaM)*
Label the KiBaM in Figure 1.

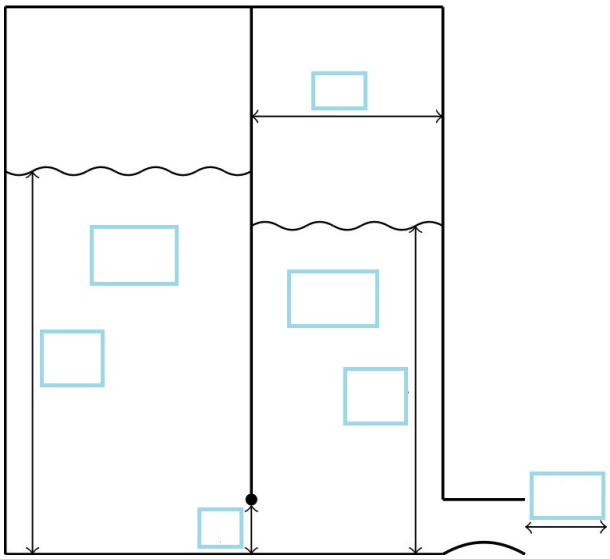


Figure 1: Unlabelled KiBaM

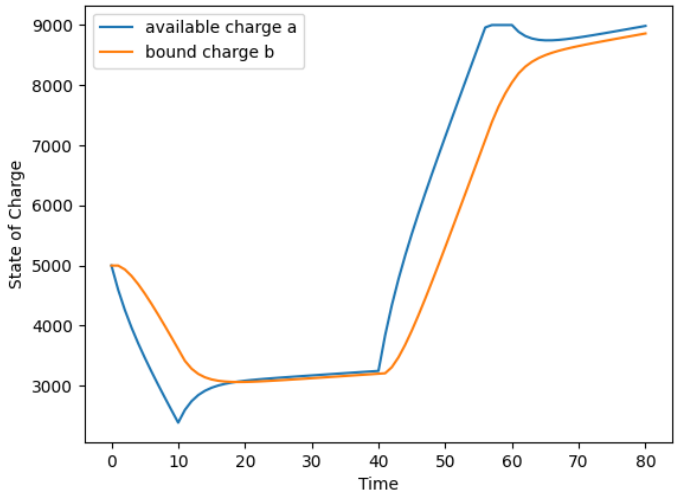
Exercise T4.2 *(A Simulation Trajectory)*

Figure 2 below shows a simulation trajectory of the available and bound charge of a KiBaM over time. The battery parameters were chosen as $p = 0.08$, $c = 0.5$ and the total capacity was set to 18 000 units. The total capacity limits the amount of charge which can be stored in the battery. Thus, if the available charge reaches its maximum capacity, we assume that all additional charge going to the available charge disappears.

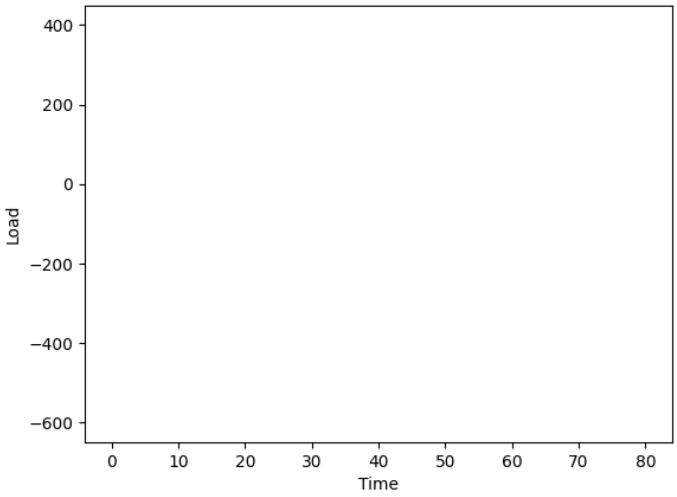
(a) Explain what happened between time point 50 and 60.

(b) Explain what happened after time point 60. Elaborate with the formulae what can be said about the relation of applied charge and the flow rate between available and bound charge.

(c) Given the previous answers and the simulation trajectory, sketch the applied load in the empty graph. Note that the applied load over time in this simulation was modelled as a step function.



(a) Plot of the available and bound charge



(b) Empty plot to sketch applied load

Figure 2: Simulation trajectory of a KiBaM over time

Exercise T4.3 *(Some Effect)*
Figure 3 below shows a simulation trajectory of the available charge of a KiBaM over time. The battery parameters were chosen as $p = 0.08$, $c = 0.5$ and the total capacity was set to 18 000 units. The battery is discharged until time point 10. After this, no load (i.e. $\ell = 0$) is applied.

(a) What battery effect does the KiBaM capture here?

(b) Explain why this effect is happening and sketch onto the graph the trajectory of the bound charge.

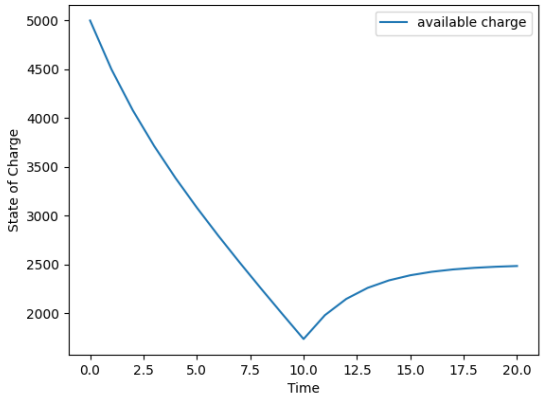
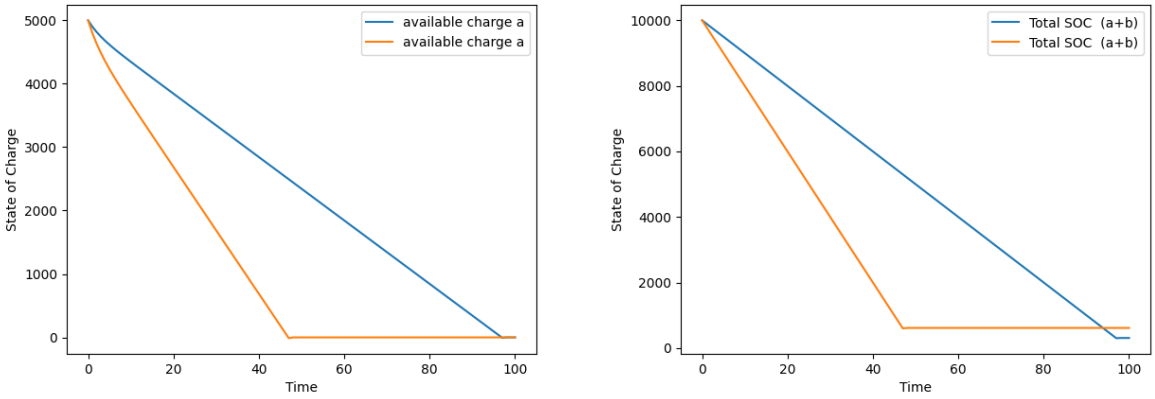


Figure 3: Plot of the simulation trajectory of $a(t)$

Exercise T4.4 *(Another Effect)*
Figure 4 below shows two simulation trajectories of the available and total charge of a KiBaM over time. The battery parameters were chosen as $p = 0.08$, $c = 0.5$ and the total capacity was set to 18 000 units. The battery is discharged for the entire simulation. As soon as a reaches 0 the simulation is halted and the battery is assumed dead and unusable.

(a) How do these two simulation trajectories differ and why?

(b) What battery effect does the KiBaM capture here?



(a) Available charge over time

(b) Total charge over time

Figure 4: Plots of two simulation trajectories (blue and orange)