BATTERY CHARGING: BATTERY STATE OF CHARGE (%)

Example:

- Assume battery capacity is 25 Ah
- Assume a **fully discharged** cell
- Charge the battery at $2A$ current for 4 hours, the total will add to: 2A*4h = 8Ah
- State of charge of the battery at the end of charging cycle (**Coulomb-Counting**):

$$SOC = \frac{Total\ Charge\ Input}{Maximum\ Cell\ Capacity} = \frac{8\ Ah}{25\ Ah} = 32\%$$

BATTERY CHARGING: TIME DOMAIN

- This method is a traditional method used for SOC calculation
- The method is also known as ***book keeping***, current integration is performed and is compared to the nominal battery capacity thus SOC can be calculated

$$z(t) = z(0) - \frac{1}{C_n}\int_0^t \eta_i i(\tau) d\tau$$

  - C_n is the battery nominal capacity
  - $z(t)$ is the cell state of charge
  - $i(\tau)$ is the instantaneous cell current
  - **Sign convention:** $(+)$ **for discharge,** $(-)$ **for charge**
  - t is the time.
  - η_i: Coulomb efficiency

BATTERY CHARGING: ADVANTAGES/DISADV.

Advantages:

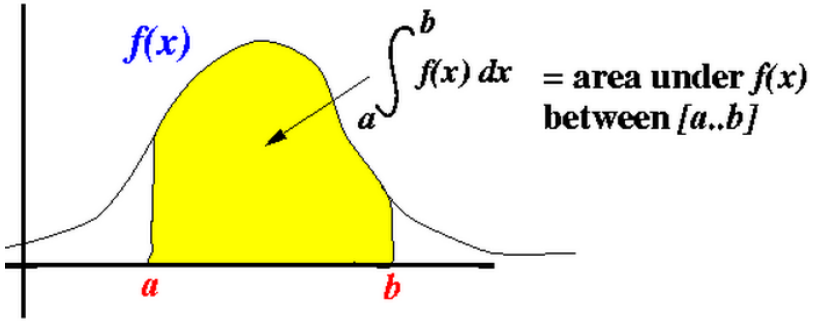
- The main advantage of coulomb counting is that it is **simple** to be implemented
- It can be applied to **all battery chemistries**

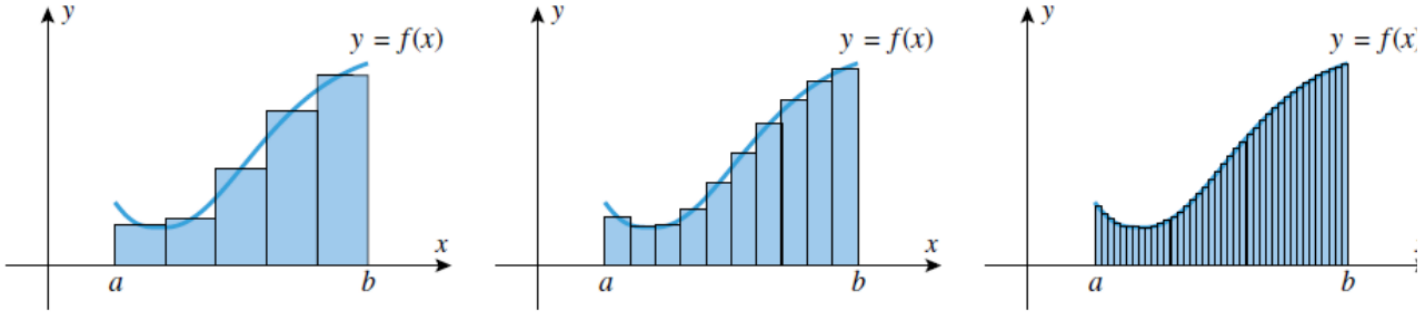
Disadvantages:

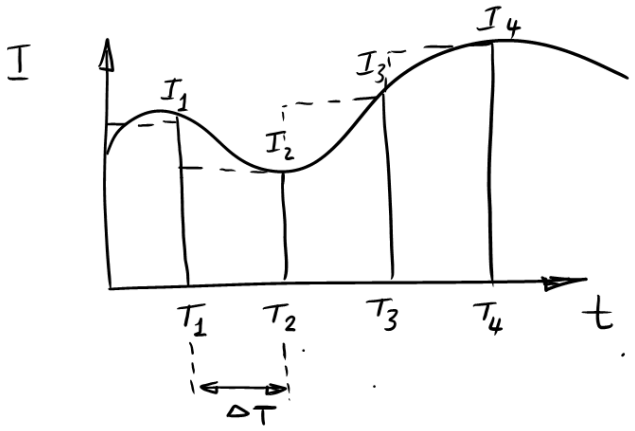
- Requires regular need for **calibration** since **error accumulation** occurs (due to sensor noise and inaccuracies) over time due to integration.
- A **complete charge and discharge** has to be conducted which **limits its practical applications**
- Requires an accurate **initial SOC** in order to provide an acceptable accuracy
- Additional information such as **cell temperature**, **charge/discharge efficiency**, and **capacity degradation** due to cycling can **enhance the accuracy** of the coulomb counting technique

BATTERY CHARGING: DISCRETE TIME DOMAIN

- Integration of the function $f(x)$ represents the area under the curve







$$SOC_{k+1} = SOC_k - \left(\frac{\Delta t}{C_n}\right) i_k$$

http://www.mathcs.emory.edu/~cheung/Courses/170/Syllabus/07/rectangle-method.html