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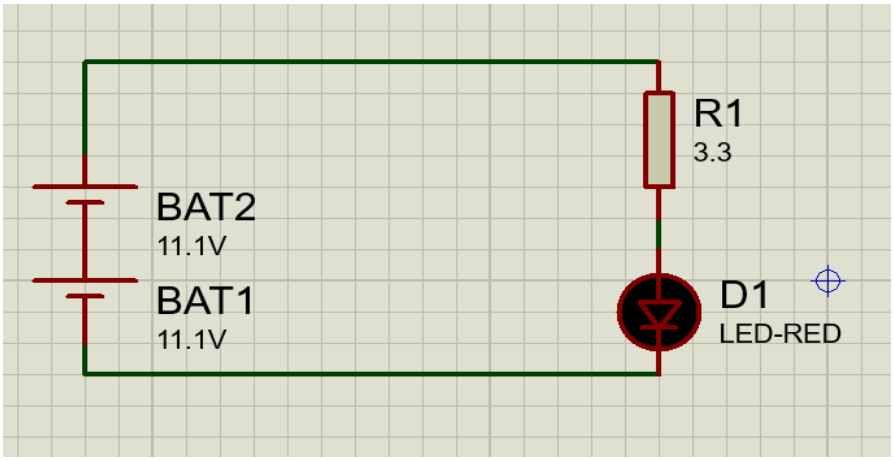
Task 2.3

Assumptions:

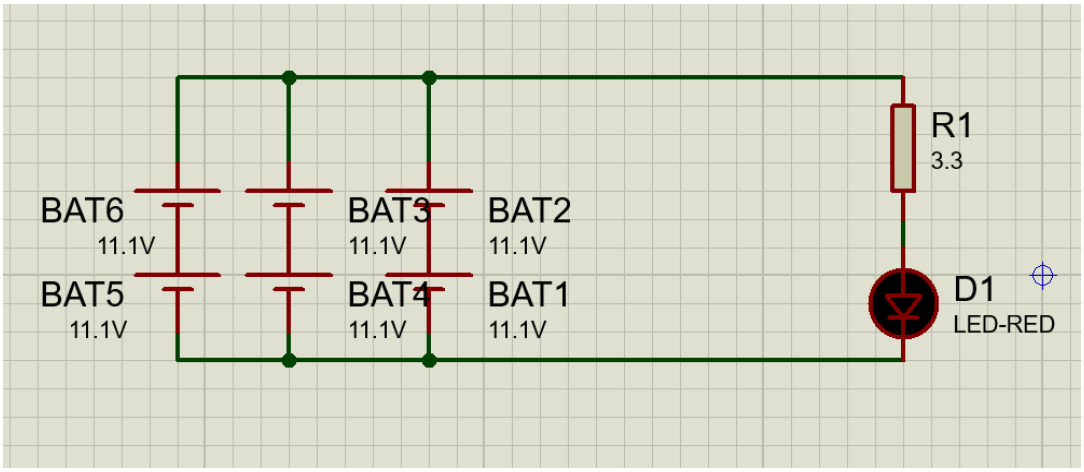
- Given the battery voltage is 11.1 volts.
- The load voltage is 12 volts for the LED in addition to 3.3 ohms current-limiting resistor.
- Battery C-rate 80, capacity 5200mAh.
- **Therefore**, we will need two batteries connected in series to provide the required voltage, which is above 12 volts, with a constant battery capacity of 5200mAh.
- **The Following Calculations are approximate ones, assuming that the battery will not reach it's cut off voltage or its Nominal voltage within the 5 hours of operation.**

Calculations:

- We will have two batteries connected in series, so we get a total voltage of 22.2 volts, with a load connected in series to them of 3.3 ohms resistor and a 12 volts LED.
- The voltage on the resistor will be 10.2 volts, therefore the total current in the circuit will be around 3.09 Amp.
- Shown below, is the connection of this circuit.



- Hence, based upon the above calculations the total battery life will only be 1hr and 41 mins.
- So, in order to increase the capacity of the battery we will add other sets of two batteries in parallel to this one.
- We need a minimum of 5 hours provided current of 3.09 Amps, therefore the capacity we need is 15450 Ah, therefore we will use 3 parallel sets of batteries each with 5200mAh and 22.2 volts, to get in total 15600 mAh and 22.2 volts as a source.
- The total number of batteries required is 6 as shown in the below circuit diagram.



Bonus:

The above calculations were theoretical and unpredictable in real-time performance, as each battery is affected by external processes, that affect its charge and battery health.

Accordingly, not all the cells will have the same state of charge or discharge, thus this needs to be monitored to prevent any crash in the system or damaging some of the cells or the components.

Thus, we need to use a BMS and here we will use **Active Cell Balancing**, which is composed of a microcontroller that keeps measure of the values of the SOC and Health of each battery, and accordingly control switches or transistors that operate on capacitors and pass a signal to charge the weak batteries (**Low in SOC**).

The process requires transistors/switches, a microcontroller, and capacitors/inductors (**Mainly Capacitors**), in addition to the cells.

The Process is explained in the following circuit diagram: