Homework 1

9/12/2024 updated

9/26/2024 due

Prof. Chang is building a pulsed-power system using a capacitor bank with total capacitance of 5 μF. The system operates with a charging voltage of 20 kV storing a total energy of 1 kJ. For safety, the capacitor bank is connected to a dump resistor R_1 via a normally-closed relay as shown in the following figure. The dump resistor is used to dump all energy in the capacitor bank with fully charged in 10 ms in the case of aborting an experiment. The definition of the safety voltage is below 10 V. Please determine what's the required resistor of the dump resistor R_1? [10 points] What's the minimum averaged power P_1 within 5 times of the discharge time constant of the resistor? [5 points] To prevent that the relay is malfunction such that it doesn't close, a redundant dump resistor R_2 is constantly connected to the capacitor bank in parallel. The redundant dump resistor needs to be very large so that the energy is discharged slowly or the capacitor bank can not be charged. However, Prof. Chang requests that the redundant dump resistor discharges the energy in the capacitor bank with fully charged to a safe level in 15 mins. Please determine what's the required resistor of the dump resistor R_2? [10 points] What's the minimum averaged power P_2 of the resistor? Please consider the required power during the charging state and the dumping state. [10 points]