School of Electrical Engineering & Telecommunications

ELEC1111 Tutorial 4

It's all about light!

1. Analysis of a flashing lamp

The circuit below is used to control a flashing light. The lamp in this circuit starts to conduct whenever the lamp voltage reaches 15 V. During the time the lamp conducts, it can be modeled as a 10 kΩ resistor. Once the lamp conducts, it will continue to conduct until the lamp voltage drops to 5V. When the lamp is not conducting, it behaves as an open circuit.

To begin the analysis, we assume that the circuit has ben in operation for a long time. Let t = 0 s at the instant when the lamp stops conducting. Thus, at t = 0 s the lamp is modeled as an open circuit, and the voltage drop across the lamp is 5V.

Q1. Find the time instant when the lamp starts to conduct (i.e. time instant when lamp voltage reaches 15V and stops behaving as an open circuit).

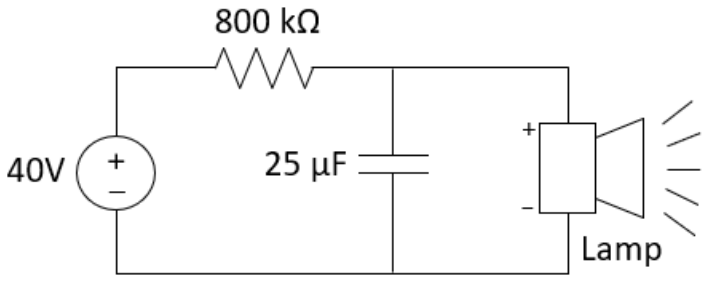
Answer: t1 = 6.73 s

Q2. Find the time instant when the lamp will stop conducting (i.e. time instant when lamp voltage drops to 5V and stops behaving as a 10 kΩ resistor).

Answer: t2 = 7.02 s

Q3. How many times per minute will the lamp turn on?

Answer: N = 8.55 flashes per minute



2. Analysis of a touch switch[1]

The circuit shown below is used to test a "touch-switch" (Sw B), which detects the touch of a finger by the capacitance of the human body. The body can be modelled as a 100 pF capacitor relative to ground, and the resistance of the arm can be modelled as a 1.5 kΩ resistor.

[1] This problem is from the mid-semester exam in Semester 2, 2018 (full solution provided under Mid-term exam -> Supplementary material in Moodle)

Q4. A person is charged to 2000 V as it walks across a carpet towards the touch-switch (Sw B). It stops in front of the touch-switch at time t = 0 s (Sw A opens). What energy is stored in the body?

Answer: w = 200 µJ

Q5. At time t = 0 s, the person touches the touch-switch (Sw B closes). Calculate and plot the current through the 100 kΩ resistor for the first 50 µs. Ensure your plot is to scale and has at least three labelled values**.**

Answer: $i_{100k} = 19.7\, e^{-98522t}$ mA