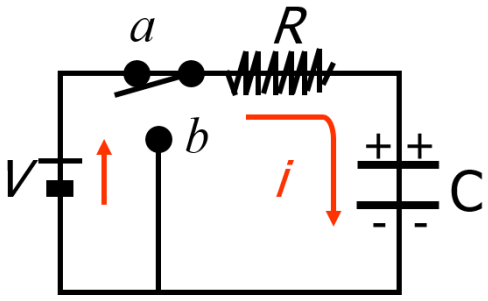
VICTORIA
UNIVERSITY OF WELLINGTON
TE WHARE WĀNANGA
O TE ŪPOKO O TE IKA A MĀUI

ENGR142 2018, 2nd Trimester
Lecturers: B. Ruck, F. Natali, and C. Hollitt

Assignment 7 Due date: 11:59 PM, Friday 5th October 2018

Problem 1: RC circuit: charging capacitor *(5 marks)*

Consider the following RC circuit: resistance R (1000 Ω) and capacitance C (4-μF) in series with a battery of emf 12-V. We consider that the capacitor is initially ***fully discharged***.



When the switch is closed (position a), the capacitor will gradually charge up through the resistor until the voltage across it reaches the supply voltage of the battery. The manner in which the capacitor charges up has been discussed during the lectures, and the instantaneous charge q on the charging capacitor can be described by the following equation:

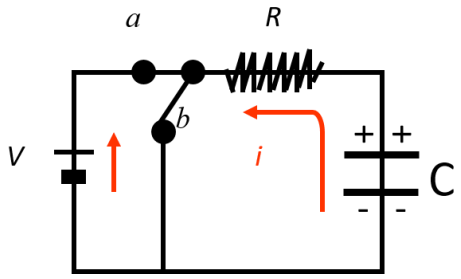
$$q = CV\left(1 - e^{-t/RC}\right)$$

a) What is the charge on the capacitor after one time constant $\tau = RC$?

b) What is the current *i* after one time constant τ = RC?

Problem 2: RC circuit: discharging capacitor *(10 marks)*

Consider the following RC circuit: resistance R (1000 Ω) and capacitance C (4-μF) in series with a battery of emf 12-V. We consider that the capacitor is initially ***fully charged.***



When the switch is closed (position a), the capacitor will gradually discharge down through the resistor.

a) Use the Kirchhoff's loop rule to demonstrate that the instantaneous charge q on the discharging capacitor can be given by the following differential equation:

$$q = -RC\frac{dq}{dt}$$

b) Show that the following expression of q is a solution of the differential equation obtained in question a):

$$q = q_0 e^{-t/RC}$$

c) Find the current i for the discharging capacitor.

Problem 3. Kirchhoff's rules *(10 marks)*

Find the currents I_1, I_2 and I_3 flowing in the circuit shown below: