

### 1.9. Series RC circuit response to a unit-step signal

A unit-step function  $u(t)$  can be considered a causal constant source (e.g., a battery in a circuit if the units of  $u(t)$  is volts).

- (a) From basic principles consider the response of an RC circuit to  $u(t)$ —that is, a battery connected in series with the resistor and the capacitor. Remember that the voltage across the capacitor results from an accumulation of charge, and that the presence of the resistor simply means that the charge is slowly accumulated. Therefore, plot what would be the voltage across the capacitor for  $t > 0$  (assume the capacitor has no initial voltage at  $t = 0$ ).
- (b) What would be the voltage across the capacitor in the steady state? Explain.
- (c) Finally, suppose that the capacitor is disconnected from the circuit at some time  $t_0 \gg 0$ . Ideally, what would be the voltage across the capacitor from then on?
- (d) If you disconnect the capacitor, again at  $t_0 \gg 0$ , but somehow it is left connected to the resistor, so they are in parallel, what would happen to the voltage across the capacitor? Plot approximately the voltage across the capacitor for all times and explain the reason for your plot.