The University of Sheffield
Department of Electronic and Electrical Engineering

EEE101 Problem Sheet 4

Capacitors and Inductors

Q1 **(i)** The capacitor in figure 1 is initially contains zero charge. Sketch a graph to show how the capacitor voltage varies as a function of time if the current generator has the waveform shown.

(ii) How much charge is in the capacitor at t = 8ms? (1μC)

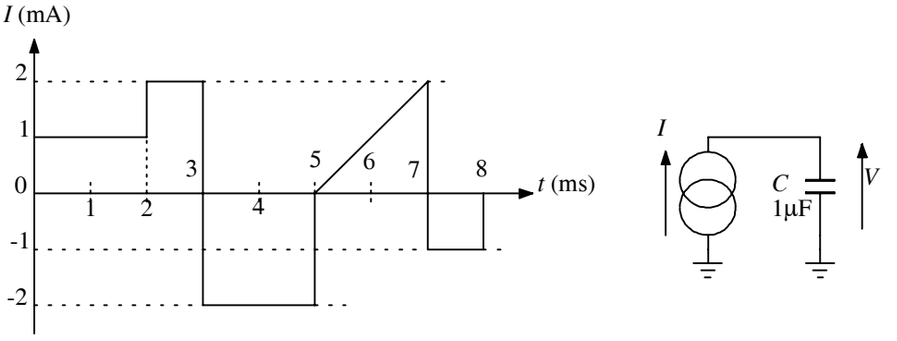

Figure 1

Q2 Draw a graph to show how capacitor current *I* in figure 2 varies with time. Work out the area and polarity of any impulsive currents. (-3μC @ 2ms, +2μC @ 6ms, -2μC @ 7ms)

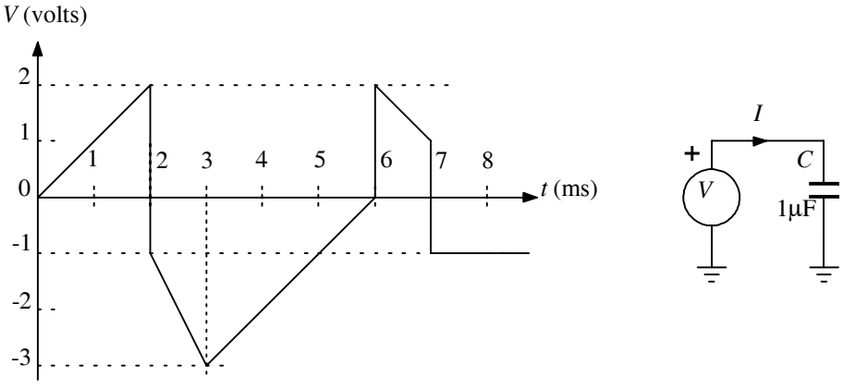

Figure 2

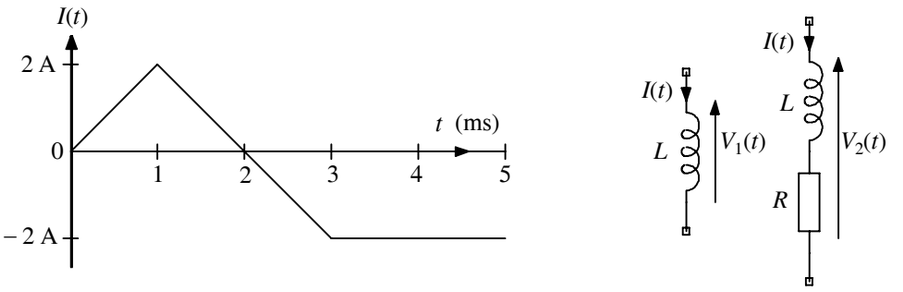

Figure 3

Q3 The current waveform, $I(t)$, of figure 3 is applied in turn to the two combinations of components shown. If $L = 10$ mH and $R = 5\ \Omega$, sketch the voltages $V_1(t)$ and $V_2(t)$ that you would expect to observe.

Q4 **(i)** Find I_S in the circuit of figure 4. [1.25 A]

(ii) Find the energy stored in all the Ls and Cs in the circuit. [330pF, 0 J; 0.1 µF, 9.45 µJ; 1 µF, 12.5 µJ; 10 µF, 281 µJ; 10 mH, 7.82 mJ; 0.1 H, 0 J; 0.15 H, 117 mJ]

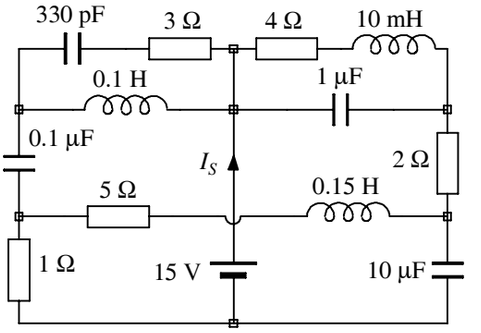

Figure 4

Q5 A particular 1mH inductor, in parallel with a capacitance C, is driven by a 2 A current source.

(i) What is the voltage across the inductor? [0 V]

(ii) What is the energy stored in the inductor? [2 mJ]

(iii) What is the energy stored in the capacitor? [0 J]

The 2 A current source is suddenly switched off so that the only path the inductor can find to keep a continuous current flowing is into C. Eventually all of the inductor's stored energy ends up in C.

(iv) What is the maximum voltage that occurs across L and C after switch off for $C = 1$ nF, $C = 10$ nF and $C = 100$ nF? [2 kV, 632 V, 200 V]

Note: Capacitors are often used in this way to limit the peak voltage across an inductor that occurs when current is suddenly switched off. Furthermore the idea of charging an inductor with energy and then dumping that energy into a capacitor is the basis of many modern power supplies.