The University of Sheffield
Department of Electronic and Electrical Engineering

EEE103/EEE121/EEE141 Problem Sheet

Background Knowledge Exercises

1 Work out in symbolic terms the Thevenin equivalent circuit of figure 1.

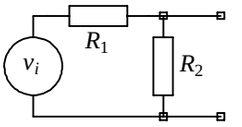

Figure 1

2 Analyse figure 2 using loop analysis and superposition and hence evaluate I_1 and V_3. Calculate the Norton equivalent circuit components that will represent figure 2. What value of V_2 would make $I_1 = 0$? (0.706A, 7.88V, I_N = 5.58, R_N = 1.41Ω, 15V)

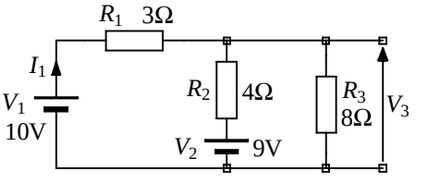

Figure 2

3 Analyse figure 3 using loop analysis and superposition and hence evaluate I_1 and V_3. Calculate the Thevenin equivalent circuit components that will represent figure 3. What value of I would make $V_3 = 0$? (3A, -6V, V_{TH} = -6V, R_{TH} = 2.4Ω, 1.25A)

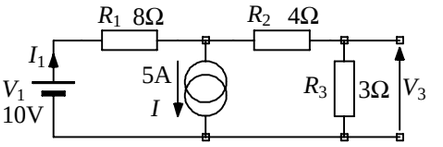

Figure 3

4 In the following equations Z represents impedance, R_X (or r_x) represents resistance, C_X represents capacitance, L_X represents inductance and ω is angular frequency. I_X is current, V_X is voltage and $_X$ is any subscript. By checking dimensional consistency, identify those equations that must be incorrect together with the term(s) causing the problem.

(i) $$I_B = \frac{V_1 - V_2}{R_4} + \frac{V_S - V_2}{R_{17} - R_9} + \frac{I_5}{R_6} + \frac{I_4}{2}$$

(ii) $$V_O - I_2 R_6 = 6V_3 + \frac{I_3 (R_1 + R_2) + I_4 (R_8 + 1)}{\frac{R_7}{R_6} + \frac{R_5}{R_4} + R_3}$$

(iii) $$r_o = \frac{\frac{(\beta + 1) R_E}{r_{be} + (\beta + 1) R_E} \cdot \frac{R_B // r_{it}}{R_S + R_B // r_{it}}}{\frac{(\beta + 1)\, R_B // r_{be}}{r_{be}\,(R_S + R_B // r_{be})}}$$ where β is a constant.

(iv) $v_i\,(j\omega)^2 C_1C_2R_1R_2 = v_o\,(1+ j\omega C_2R_1 + j\omega\,(C_1+C_2)R_2 + (j\omega)^2 C_1C_2R_1R_2 + j\omega C_2R_1R_2)$

(v) $$\frac{v_o}{v_i} = \frac{-j\omega C_2R_1}{1+ j\omega(C_1+C_2)R_2^2 + (j\omega)^2 C_1R_2C_2R_1}$$

(vi) $$Z = 1 + \frac{j\omega L}{1+ j\omega CR}$$

(vii) $$Z = \frac{R_1 - \omega^2 LCR_2 + j\omega(L + C\,R_1R_2)}{1 - \omega^2 LC + j\omega C\,(R_1 + R_2)}$$

5 **(i)** The capacitor in figure 5 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)

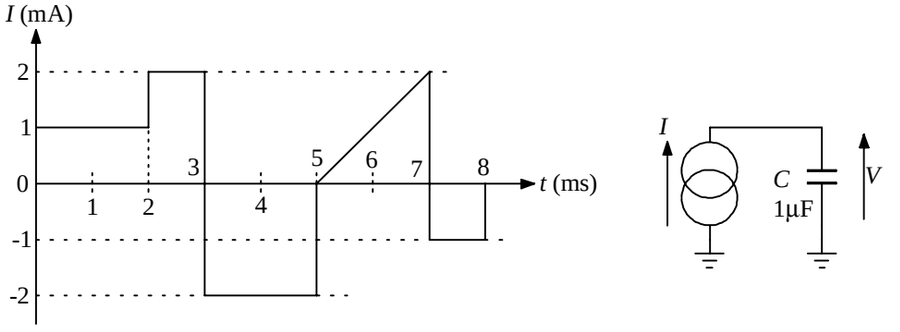

Figure 5

AND FOR EXPERTS .....

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

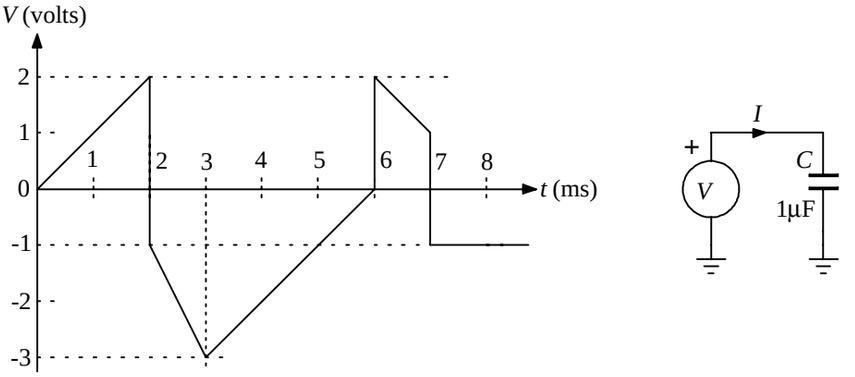

Figure 6