Data Provided: None.

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2010 - 2011 (2 hours)

CIRCUITS AND SIGNALS 1

Answer **THREE** questions. Solutions will be considered in the order in which they are presented in the answer book and **no marks will be awarded for an attempt at a fourth question.** Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

Unit multipliers: p = x10^{-12}, n = x10^{-9}, μ = x10^{-6}, m = x10^{-3}, k = x10^{3}, M = x10^{6} G = x10^{9}

1 (a) For the circuit of figure 1a, use nodal analysis to find the voltage of node **A** with respect to the reference node. **{*5*}**

Hence find the power dissipated in the 2 Ω resistor. **{*2*}**

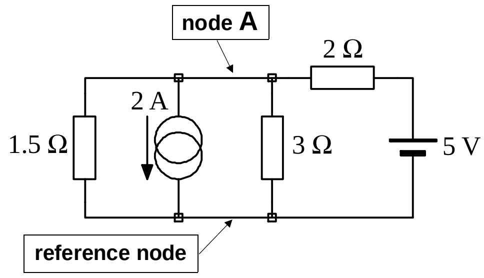

Figure 1a

(b) (i) Use the principle of superposition to find the value of V_A in figure 1b. Identify the source that makes the largest contribution to the value of V_A. **{*7*}**

(ii) Work out the power delivered by each of the three sources. *(If the source is delivering power to the rest of the circuit, take the power as positive; if the source is absorbing power, take the power as negative.)* **{*6*}**

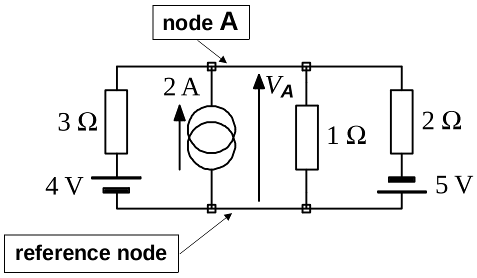

Figure 1b

2 **(a)** Find the Thevenin equivalent parameters V_{Th} and R_{Th} that will make the circuits of figure 2a (i) and figure 2a (ii) indistinguishable from the pont of view of an observer looking into terminals **A** and **B**. **{*6*}**

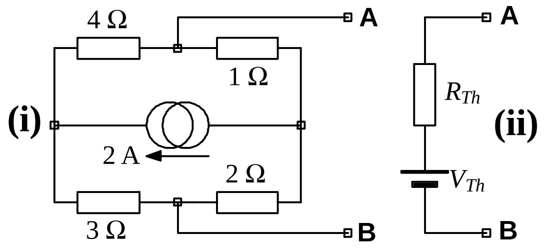

Figure 2a

(b) In figure 2b V_1 is a 100V dc source that has been connected for a long time

(i) Calculate the magnitude of the current *I*. **{*2*}**

(ii) Evaluate the energy stored in *L*. **{*2*}**

(iii) Evaluate the energy stored in *C*. **{*2*}**

The energy stored in inductors and capacitors is given by $E = \dfrac{LI^2}{2}$ and $E = \dfrac{CV^2}{2}$.

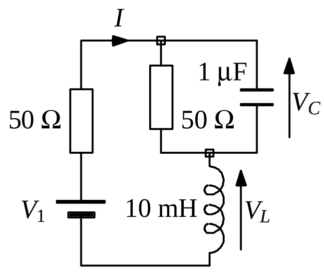

Figure 2b

(c) The source in figure 2b is changed to the step waveform of figure 2c. This waveform is constant at -10 V from $t = -\infty$ to $t = 0^-$ and constant at $+20$ V from $t = 0^+$ to $t = +\infty$.

(i) What are I, V_L and V_C at $t = 0^-$? **{*3*}**

(ii) What are I, V_L and V_C at $t = 0^+$? **{*5*}**

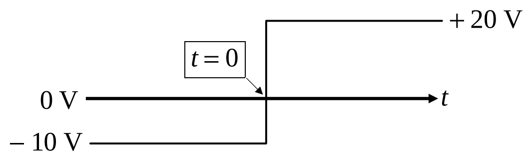

Figure 2c

3 **(a)** **(i)** For the circuit of figure 3a, show that the impedance V/I is given by

$$Z = R\,\frac{1 + j\omega\dfrac{L}{R} - \omega^2 LC}{1 + j\omega CR}\,. \quad \{3\}$$

(ii) Using the result of part **3 (a) (i)**, find the angular frequency, ω, at which the circuit is resonant. **{*5*}**

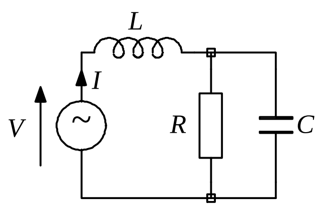

Figure 3a

Q3 CONTINUED ON THE NEXT PAGE

(b) For the circuit of figure 3b.

(i) Find I and V_1 and express each result in complex $(a + jb)$ and polar $(r\angle\theta)$ form. ***{8}***

(ii) What is the impedance of the circuit from the source point of view? Give your answer in polar form. ***{2}***

(iii) If the capacitor reactance is changed to $-j10\ \Omega$, what are the new values of I and V_1? ***{2}***

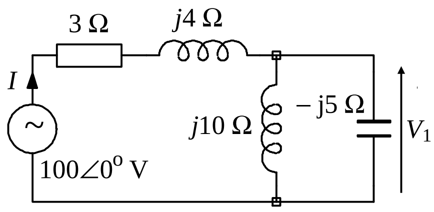

Figure 3b

4 **(a)** **(i)** What is meant by the term "low-pass filter"? ***{2}***

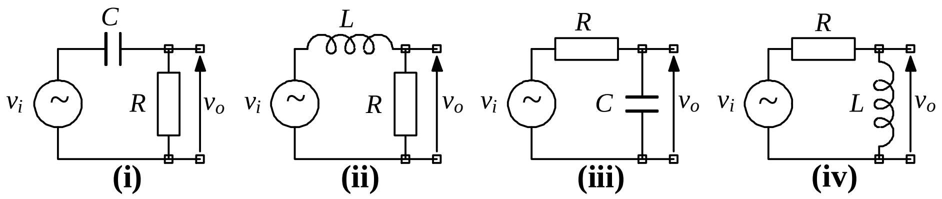

Figure 4a

(ii) Identify which of figures 4a (i), (ii), (iii) and (iv) are low pass circuits. ***{2}***

(iii) **Sketch** the shape of v_o/v_i response that you would expect from a low pass filter using a vertical axis that expressed v_o/v_i in dB and a horizontal axis that expressed frequency on a logarithmic scale. Identify on your sketch the pass band region and the corner frequency and quantify the the roll off rate in the stop band region. ***{6}***

(b) **(i)** The impedance, Z, in figure 4b consists of two components in series. If $I = 0.532\angle 57.8^{o}$ A when $V_S = 10\angle 0^{o}$ V and $f = 1$ kHz, find the values of the two components. ***{6}***

(ii) An inductance of 2.53 mH is placed in series with Z. What is the voltage across this inductance and the total power dissipation in the circuit if f remains at 1 kHz. ***{4}***

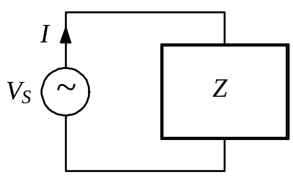

Figure 4b

4RCT/GWJ
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