Data Provided: None

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2007-2008 (2 hours)

Circuits and Signals 1

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. 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.**

1. **a.** Write down the Superposition Theorem applied to networks containing more than one source. **(2)**

b. Using the Superposition Theorem, determine the current, *I*, flowing through the 4Ω resistor in the DC circuit of fig 1a.

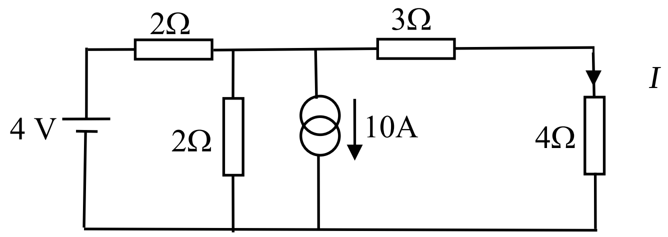


Fig 1a **(8)**

c. Find the Thevenin equivalent circuit between A and B for the circuit shown in figure 1b.

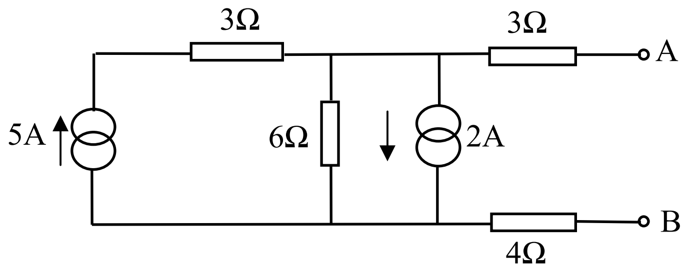


Fig 1b

A rechargeable battery of nominal voltage of 15V is connected between A and B (positive terminal connected to A) of fig 1b. Determine whether this battery will receive or deliver power and find the magnitude of the current passing through it when it is fully charged (15V). Assume that the battery has a negligible internal resistance. **(10)**

2. **a.** State in what form the energy is stored in a capacitor and an inductor. Explain how you could establish stored energy in each. Indicate how you might recover this energy. **(6)**

b. From first principles, show that the energy stored in an inductor is given by

$$E = \frac{1}{2} L I^2$$

Where L is the value of the inductance and I is the DC current flowing through it. **(4)**

c. A resistor, R, and an uncharged capacitor, C, are suddenly connected to a DC voltage source, V, at time t = 0. Derive an expression for the current flowing in the circuit as a function of time for t > 0. Sketch the variation of the voltage across the resistor and the voltage across the capacitor as a function of time for t > 0, identifying the important points in terms of R, C and V **(10)**

3. **a.** State Thevenin's theorem for ac circuits and define how the Thevenin equivalent circuit is derived. **(4)**

b. Find the Thevenin equivalent circuit for fig 3b with respect to the terminals AB. All sources are sinusoidal.

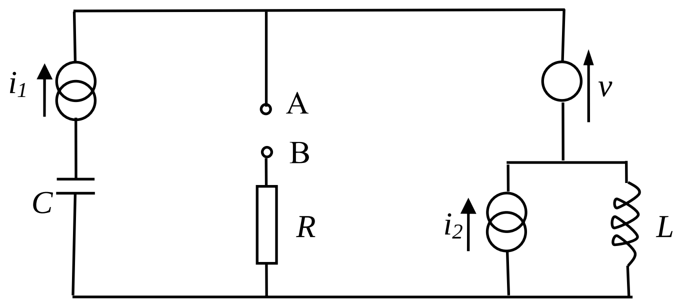


Fig. 3b **(6)**

c. The 100 V peak sinusoidal source supplies the circuit shown in fig 3c. The reactance values are appropriate for the frequency used. Find the peak current drawn from the voltage source and the phase angle between this current and the voltage.

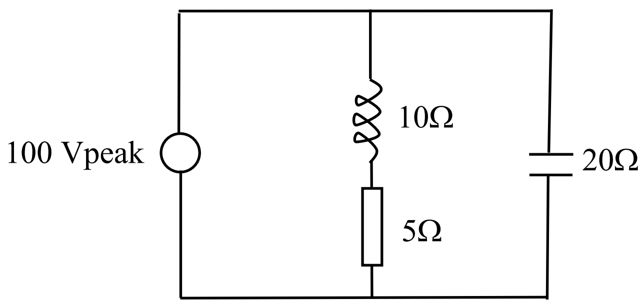
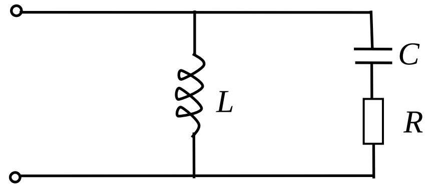


Fig. 3c

(10)

4. **a.** State the definition of resonance for *RLC* ac circuits. **(2)**

b. Derive an expression for the resonant frequency for the circuit in fig 4.



(8)

c. For an *RLC* series circuit, sketch curves showing the variation of current, resistance, overall impedance, inductive reactance, capacitive reactance and overall reactance as a function of frequency. Identify the resonant frequency. **(6)**

d. A series *RLC* circuit is excited by a variable-frequency sinusoidal voltage source having an rms value of 5 V. When varying the frequency around the point of resonance, the current was found to reach a maximum at 20 mA and reduce to (20 mA)√2 at both 28.5 kHz and 31.5 kHz. Determine the values of *R* and *L*. **(4)**

PAH / RCT