University of Moratuwa, Sri Lanka

B. Sc. Engineering Degree Course

Final Part I Examination 1997/98

UEE 201 - THEORY OF ELECTRICITY

0900 - 1200 hrs 30 June 1999

Answer **FIVE** Questions Only. Question 1 carries 28 marks, and all other Questions carry 18 marks each

Permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ H/m Permittivity of free space = 8.854×10^{-12} F/m

1 (a) Calculate the value of the impedance Z_{AC} in the delta equivalent of the circuit shown in figure Q1abc. [4 marks]

(b) Obtain the parameters **A** and **C** in the transmission line parameters for the two port network shown in figure Q1abc. [3 marks]

(c) If an alternating voltage of 100V is applied across Port 1 of the circuit shown in figure Q1abc, determine the Thevenin's equivalent circuit across Port 2. [4 mark]

(d) Write down the Kirchoff's Voltage law equation for the loop 1 in figure Q1d and express it in a simplified form. [3 mark]

(e) An alternating voltage source of 200 V, has an internal impedance of (1 + j 2) Ω. It supplies a variable load of power factor 0.8 lagging. Determine the values of resistance and reactance of the load when receiving maximum power from the supply. [6 mark]

(f) For the periodic waveform shown in figure Q1f, determine the **mean value**, **average value**, **rms value** and **form factor**. [4 mark]

(g) A toroid of magnetic material (μ_r = 1500) of length 20 cm and cross section area 0.8 cm^2 has a cut of 1 mm in its circumferance. 500 turns are uniformly wound on the circumferance. Determine the total reluctance of the magnetic path and the inductance of the coil. [4 marks]

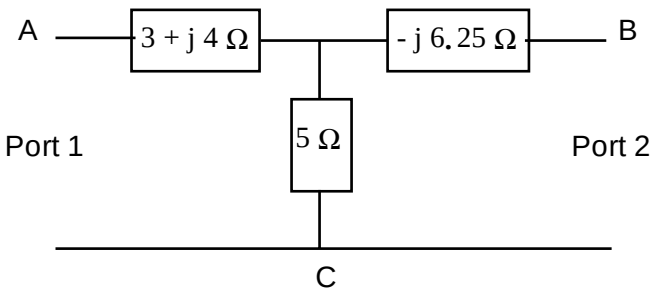

Figure Q1 abc

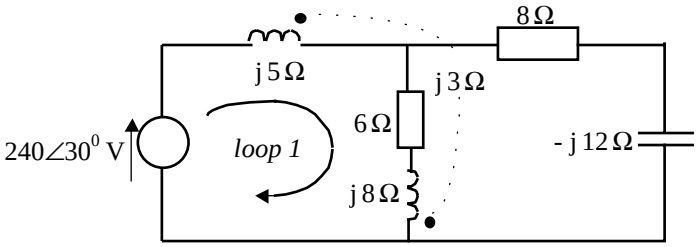

Figure Q1d

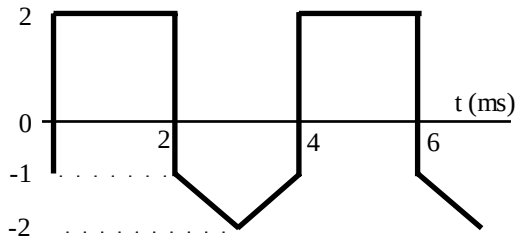

Figure Q1f

2 For the circuit shown in figure Q2, determine from first principles the currents in all the branches. The mutual inductances between the inductances L_1, L_2 and L_3 are M_{12}, M_{23} and M_{31}.

The component values are $R_1 = 0.36R$, $R_2 = R_3 = R$, $X_{L1} = X_{L2} = X_{L3} = 1.2\ R$, $X_{M12} = X_{M23} = X_{M31} = R$ and $E/R = 7$. [18 marks]

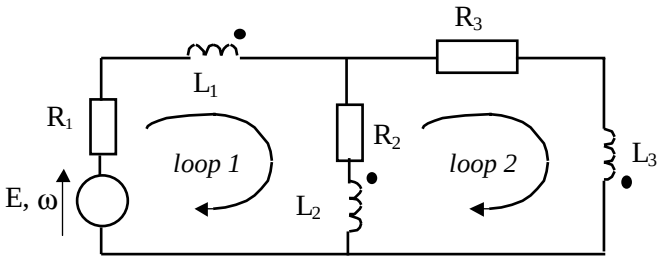

Figure Q2

3 A certain circuit consists of two components Z_1 and Z_2 in series. When an alternating voltage of magnitude 234 V is applied across the combination, the magnitude of the current is measured to be 1.8 A. With this current, the active power loss in the circuit is measured to be 417.7 W and the voltage magnitudes across Z_1 and Z_2 are each found to be equal to 234 V. Determine possible values for the resistive and reactive components of Z_1 and Z_2. [18 marks]

4 A 50 Hz, balanced, 3 phase source supplies a balanced load consisting of three impedances (R = 4 Ω in series with L = 10 mH each) connected in star, at 400 V. Determine (a) the line current, and (b) the active power consumed. [6 marks]

If each of the three wires connecting the load to the supply has an impedance of (r = 1Ω, l = 5 mH), determine (c) the line voltage at the supply, and (d) the power factor at the supply. [6 marks]

It is required to improve the load power factor to 0.95 by the use of a delta connected capacitor bank. Assuming that the load voltage remains at 400 V, determine (e) the values of the 3 capacitors required.[6 marks]

5

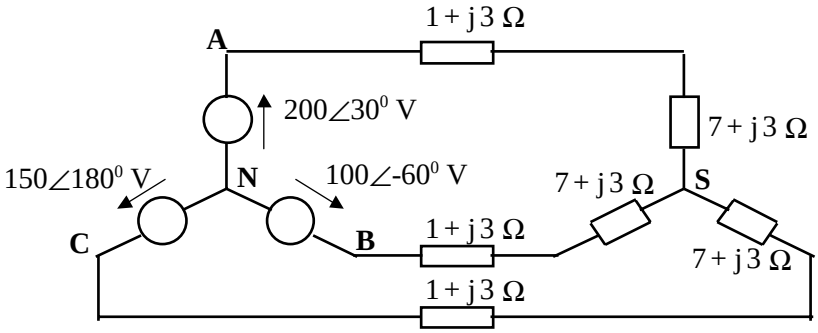

Figure Q5

Figure Q5 shows an unbalanced star connected source supplying a balanced star connected load through wires of equal impedance. Determine using Millman's theorem the current in each line.

[8 marks]

Determine the symmetrical components of these three line currents. [6 marks]

Using the property that the load is balanced, determine the symmetrical components of the voltages across the load. [2 marks]

Determine the power consumed by the load. [2 marks]

6 (a) A certain two port network has an impedance matrix with $z_{11} = 10 + j10$, $z_{12} = j10$, $z_{21} = j10$ and $z_{22} = 10 + j10$. Determine the corresponding two port transmission line parameter matrix. [4 marks]

(b) For the circuit shown in figure Q6, write down the node-branch incidence matrix. [3 marks]

Write down the Node admittance matrix by inspection [4 marks]

Hence determine the voltages at nodes 1, 2 and 3. [7 marks]

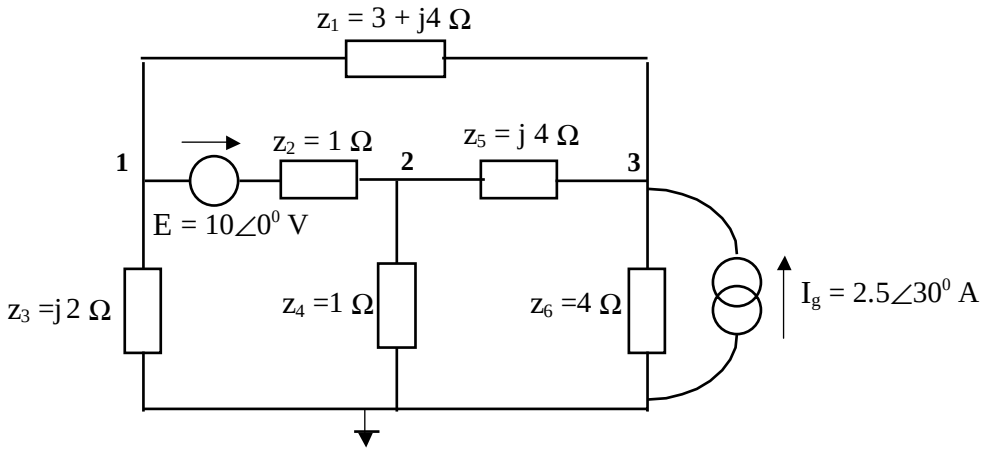

Figure Q6

7 Figure 7 shows the current passing through a certain power electronic device. Determine the Fourier series of this current to 3 significant terms. [14 marks]

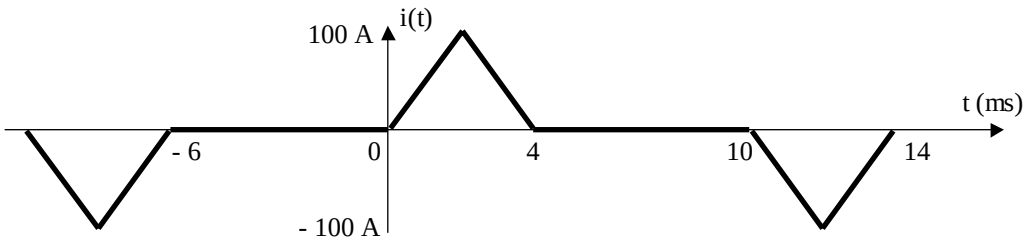

Figure Q7

This current is passed through a series combination of a resistance of 100 Ω and an inductance of 100 mH. Determine the fundamental term of the Fourier series of the voltage across the combination.

[4 marks]

8 For the transient current waveform shown in figure Q8, determine from first principles the Laplace Transform. [6 marks]

This transient current passes through a series combination of an inductance L = 2 mH and a resistance R = 1 Ω.

(a) Determine the transform of the voltage appearing across the combination. [6 marks]

(b) Determine the inverse transform of the voltage and sketch the waveform of the voltage. [6 marks]

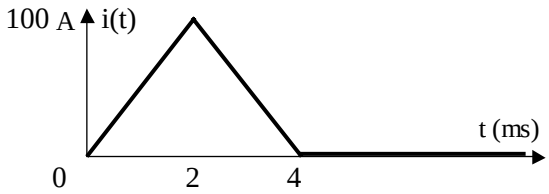

Figure Q8