University of Moratuwa, Sri Lanka

B. Sc. Engineering Degree Course

Level 2 – Semester I Examination 2002/03

EE 201 - THEORY OF ELECTRICITY

Time Allowed: Three Hours | 10 December 2002.

Answer **All** Questions. | Total marks for the paper is 70 marks.

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

1 (a) Sketch the circuit diagram of a residual current circuit breaker showing the basic principle of its operation. [2 marks]

(b) For the circuit shown in figure Q1, determine the currents in all the branches. [6 marks]

(c) Sketch the phasor diagram showing the branch currents and supply voltage. [2 marks]

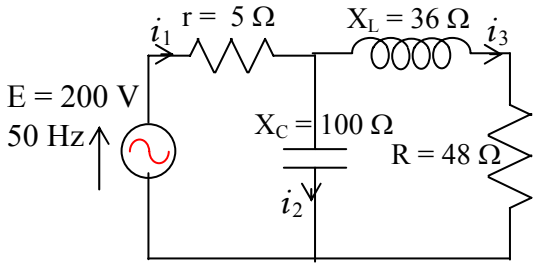

Figure Q1

2 (a) Figure Q2 shows a mutually coupled circuit supplied from a variable frequency source. Determine an expression for the effective impedance of the circuit. [4 marks]

(b) Determine the frequency at which resonance occurs, the Q factor at resonance, and the current at resonance. [4 marks]

(c) Determine also the voltage drop across the inductor L_1 at resonance. [2 marks]

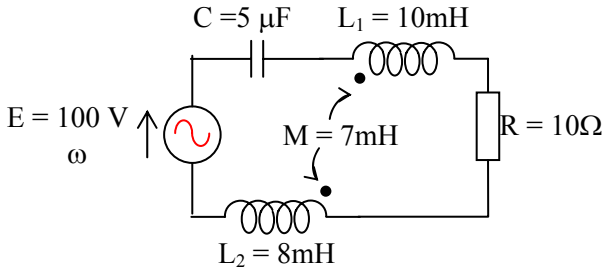

Figure Q2

3 (a) Determine the Thevenin's equivalent circuit across the terminals AB, of the circuit shown in figure Q3. [6 marks]

(b) Using the above result or otherwise determine the value of R for which maximum power will be transferred and the value of this maximum power. [4 marks]

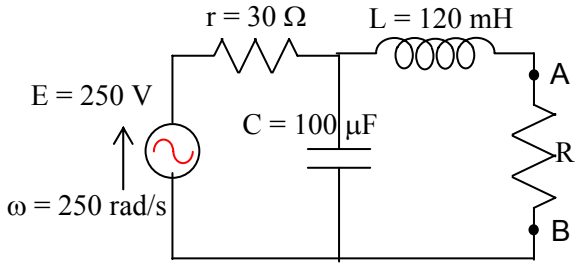

Figure Q3

4 (a) Convert the two voltage sources shown in figure Q4 to equivalent current sources. [2 marks]

(b) Hence draw the circuit for nodal analysis. Determine the nodal admittance matrix and the nodal injected current source. [3 marks]

(c) Using matrix nodal analysis, determine the currents in all the branches [5 marks]

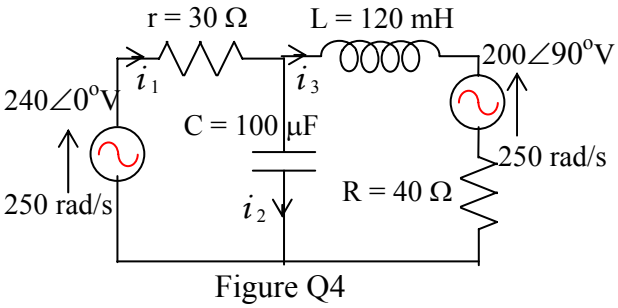

Figure Q4

5 (a) A 3 phase, 400 V, 50 Hz supply feeds a balanced star connected load, each arm consisting of an inductance of 200 mH and a resistance of 100 Ω in series. Determine the line current, the power factor of the load and the total active power supplied to the load. [3 marks]

(b) Determine the value of the 3 capacitors that must be connected across the load in delta in order to increase the overall power factor to 0.95 lag. [4 marks]

(c) Determine the Symmetrical Components of the phase "A" voltage, given that

$V_{AN} = 200\angle 0^o$ V, $V_{BN} = 100\angle -90^o$ V and $V_{CN} = 200\angle 150^o$ V. [3 marks]

6

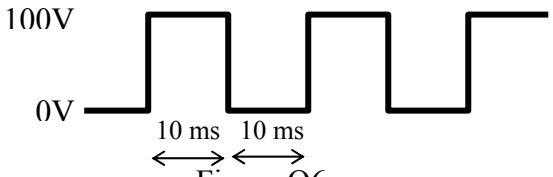

Figure Q6a

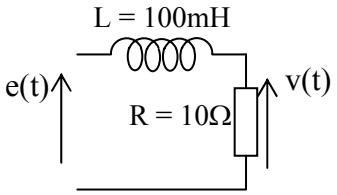

Figure Q6b

(a) Determine the first 3 significant terms of the Fourier Series of the periodic rectangular voltage waveform e(t) shown in figure Q6a. [5 marks]

(b) Determine the peak value, average value, mean value, rms value and form factor of the waveform e(t). [2 marks]

(c) If the waveform e(t) is applied across the series L R circuit shown in figure Q6b, determine the Fourier Series of the resulting voltage v(t) across the resistor R. [3 marks]

7

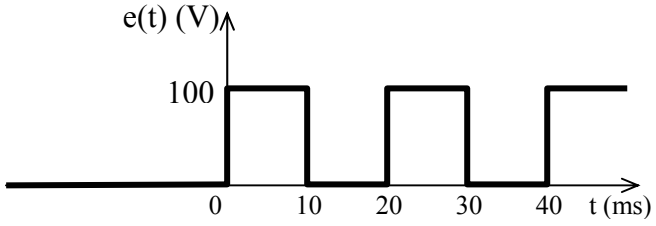

Figure Q7a

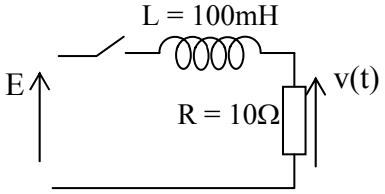

Figure Q7b

(a) Determine the Laplace transform of the causal waveform e(t) shown in figure Q7a.

[4 marks]

(b) Determine the Laplace transform of the causal waveform $A\, e^{-\alpha t}$. [2 marks]

(c) If a constant d.c. voltage E = 100V, is switched on to the circuit shown in figure Q7b, at t = 0, determine and sketch the voltage v(t). [4 marks]