THE INSTITUTION OF ENGINEERS, SRI LANKA.

PART I EXAMINATION - 2007 (New Syllabus)

ELECTROTECHNIQUES

This paper consists of ten questions. Answer any **SIX** questions only.

Time allowed : Three Hours

Electric space constant $\epsilon = 8.85 \times 10^{-12}$ Fm^{-1}
Magnetic Space constant $\mu = 4\pi \times 10^{-7}$ Hm^{-1}
Gravitational constant = $9.81 ms^{-1}$

Q 1.

What is meant by "resonance" . Show that the "quality factor" of an RLC series circuit is given by $(1/R) \times \sqrt{L/C}$.

A telegraph circuit consists of a battery with an e.m.f. of 12 V and internal resistance of 1 Ω, a non –inductive line of resistance 45 Ω and a relay of 18 Ω resistance and 1.2 H inductance. If the armature of the relay is not attracted until the current rises to 0.05 A, what interval of time will elapse between the closing of the circuit and the time when the relay begins to operate ?

Q 2.

(i)Explain the importance of the damping torque in a moving system of the instrument. Diagrammatically represent the three effects of damping on the variation of position with respect to time of the moving system of an instrument.

(ii) Explain with the aid of a circuit diagram and standard notation and symbol identification, how the permanent magnet moving coil ammeter can be arranged for extension of its range.

(iii) The permanent magnet moving coil instrument give its full scale deflection at 50mV and 10mA current. Explain how the instrument could be used

(a) as an ammeter to measure 0-10A,
(b) as an voltmeter to measure 0-250V.

Q 3.

Referring the Fig. Q3 provide answers to the following questions.

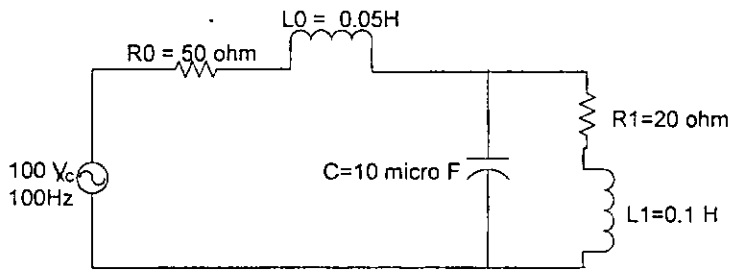


Fig Q3

(i) Determine the impedance of the parallel circuit.
(ii) Determine the total impedance seen by the source.
(iii) Find the current I_0 supplied by the source.
(iv) Determine the voltage drops V_{AC} and V_{CE}.
(v) Calculate the currents in the parallel circuit.
(vi) Show that the total power supplied by the source is equal to the power consumed by all branches.
(vii) Draw the current phasor diagram and indicate the corresponding values.

Q4.

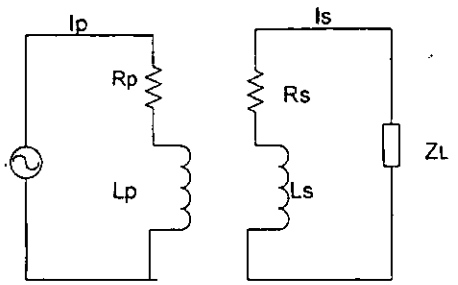


Fig Q 4.

(i) Considering the circuit shown in Fig. Q4 and assuming the load impedance is zero, show that the effective primary impedance is given by

$$Rp+j\,\omega Lp+\frac{\omega^2 m^2 (Rs - j\omega Ls)}{(R^2+\omega^2 Ls)}$$

(ii) A primary coil of inductance 7 μH and resistance 8 ohm is coupled by a mutual inductance of 1.5 to a closed secondary circuit of inductance 2 μH and resistance of 75 ohm. Calculate the resistance and reactance coupled from the secondary circuit into the primary at frequency of $50/2\pi$ MHz and also the Q factor of the primary circuit at this frequency.

Q5.

An unbalanced delta-connected load has 100Ω resistance, 20Ω resistance a... inductance and 30μF capacitor in the three branches respectively. The supply vol... 400V at 50Hz frequency. Draw the circuit diagram to illustrate the conditions given. Calculate,

(i) The phase current

(ii) The line currents showing the phasor diagram for each case.

Draw the phasor diagram and indicate the values in the respective branches.

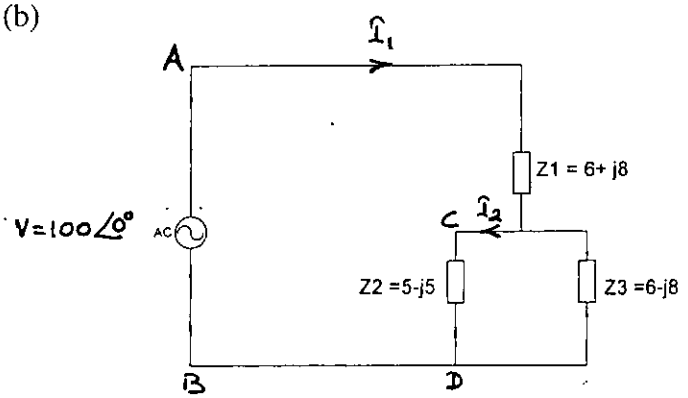
Q 6.

(a)

(i) Briefly explain the Reciprocity theorem.

(ii) State Thevenin's theorem.

(b)



Using the Thevenin's theorem find the current I_2 of the network shown in Fig. Q6, when the voltage source of 100V is connected between terminals A and B.

If a voltage source of 30V is included in the branch that carries current I_2 of the above network and the points A and B are short circuited, using Reciprocity theorem find the current through AB.

Q 7.

(i) Explain in detail the principle of operation of a miniature circuit breaker (mcb) with the help of a time current characteristics curve of a mcb.

(ii) Why earthing is necessary for an electrical installation?

(iii) With the aid of a labeled diagram indicate the earthing system used in Sri Lanka. Your diagram should show the three phase source, four wire distribution system and a single phase installation.

Q 8.

(i) State Coulomb's law. Hence determine the electric force between two cha... q_1 and q_2 separated by a distance r and kept in a vacuum. Clearly state th... units of the proportionality constant.

(ii) The total mount charge Q is uniformly distributed along a thin straight non conducting rod of length L kept in a vacuum. A point charge of q is kept along the longitudinal centre line of the rod at a distant d away from the one end of the rod. Derive and expression for the total electrostatic force due to the rod on the point charge q.

Q 9.

(i) State two Faraday's laws of electromagnetic induction.

(ii) Derive the equation for induced e.m.f. $e = -N \frac{d\phi}{dt}$.

(iii) State Lenze's law.

(iv) The time variation of the flux linked with a coil of 100 turns during a complete cycle is expressed in the following manner,

$$\Phi = 0.06 (1 - 4t / T) \text{ Weber} \qquad 0 < 1 < T/2$$

$$\Phi = 0.06 (4t/T - 3) \text{ Weber} \qquad T/2 < t < T$$

Where T represents time period and equates 0.05 seconds. Sketch the waveforms of the flux and induced e.m.f.

Detrmine the Maximum value of the induced e.m.f.

Q 10.

(i) What is meant by a "Karnough map". Illustrate your answer with an example.

(ii) In a logic design there are three bulbs red, yellow and green respectively. It is desired to ring a bell if one of the following happens.

(a) Only red and yellow bulb light
(b) Only green bulb lights
(c) Red bulb lights

Draw a logic circuit with a minimum number of gates to realize this.