NATIONAL UNIVERSITY OF SINGAPORE

EXAMINATION FOR

(Semester I: 2011/2012)

EE1002 – INTRODUCTION TO CIRCUITS AND SYSTEMS

November/December 2011 - Time Allowed: 2.0 Hours

INSTRUCTIONS TO CANDIDATES:

1. This paper contains **FOUR** (4) questions and comprises **FIVE** (5) printed pages.
2. Answer all **FOUR** (4) questions.
3. Different questions carry different marks.
4. This is a CLOSED BOOK examination but students are provided with a "Formula Sheet" that they can refer to during the course of the examination.

Q.1(a). The circuit in Figure Q.1(a) contains one independent voltage source, one dependent voltage source and one dependent current source, where the value of voltage drop across the 1 Ω resistor is v_o.

Determine the power supplied by the 10V independent voltage source.

(10 marks)

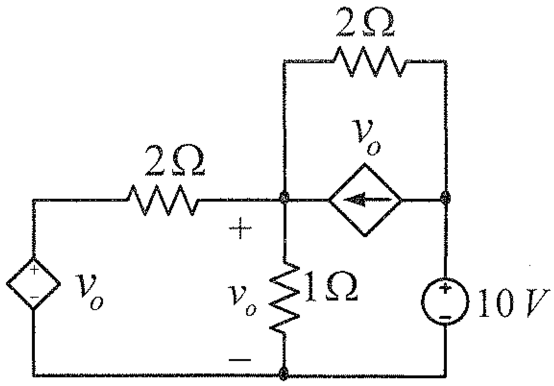

Figure Q.1(a)

(b) In the circuit given in Figure Q.1(b), find the Thevenin's equivalent of the circuit between points A and B.

(10 marks)

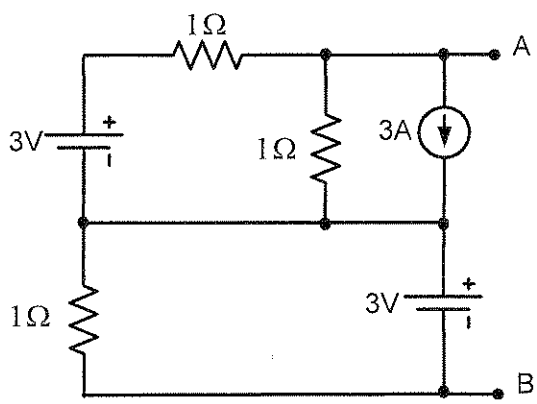

Figure Q.1(b)

Q.2(a) For the circuit given in Figure Q.2(a), switch S1 was closed and S2 was open for a long time before $t = 0$. At $t = 0$, the switch S1 is opened and S2 is closed.

(i) Find the energy stored in the inductor before $t = 0$.

(5 marks)

(ii) Find the energy stored in the capacitor immediately after $t = 0$.

(5 marks)

(iii) Find the expression for the inductor current as a function of time after $t = 0$.

(5 marks)

(iv) Find the expression for the capacitor voltage as a function of time after $t = 0$.

(5 marks)

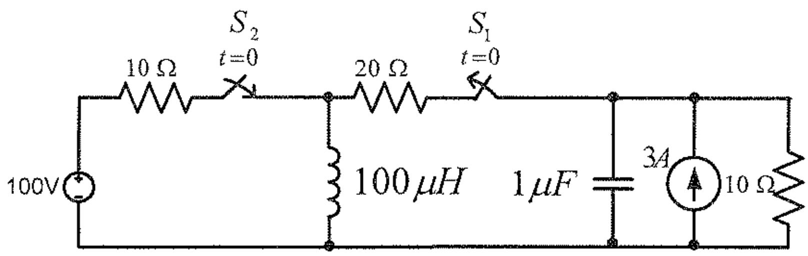

Figure Q.2(a)

(b) In the circuit given in Figure Q.2(b),

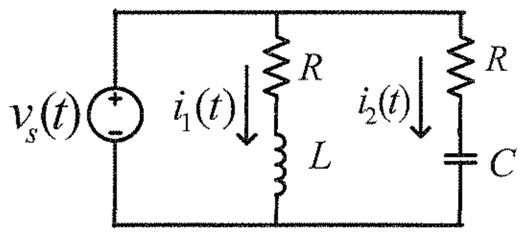

Figure Q.2(b)

$$v_s(t) = 100\cos\left(2000t + \frac{\pi}{12}\right)$$

$R = 10\Omega$

$L = 5mH$

$C = 50\mu F$

(i) Find the expressions for currents $i_1(t)$ and $i_2(t)$.

(6 marks)

(ii) Specify the RMS values for the currents $i_1(t)$ and $i_2(t)$ and the phase difference between them.

(4 marks)

Q.3 (a) A magnetic circuit shown in Fig. Q.3(a) has an iron core with infinite permeability. The core cross sectional area, A_c is 16 cm^2, the air-gap length, g is 2 mm and the mean length of the magnetic flux-path, l_c is 80 cm.

The coil has 500 turns and draws a dc current of 4 A from the source. You can neglect the magnetic flux leakage and fringing effect.

Determine

(i) the flux in the magnetic circuit,

(ii) the flux-linkage of the coil and

(iii) the inductance of the coil.

(10 marks)

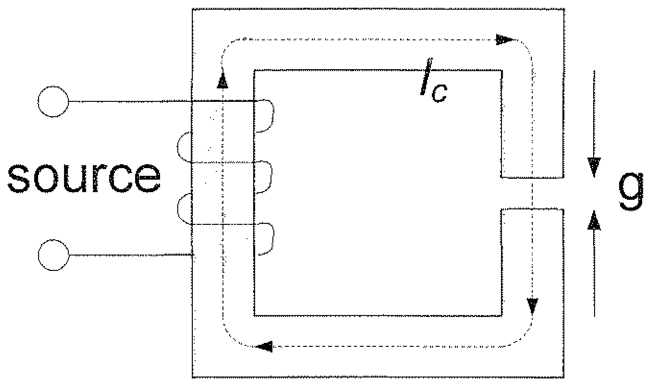

Figure Q.3(a)

(b) A 2400/240 V, 150 kVA, and 50 Hz single-phase transformer has an equivalent circuit series impedance of $Z_{eq} = 0.5 + j\ 1.5\ \Omega$ referring to the high-voltage side. The magnetizing impedance is large and can be ignored. The transformer is supplying the rated load at 240 V and 0.85 power factor lagging.

Determine

(i) the voltage regulation in percentage and

(ii) the efficiency of the transformer while supplying the above mentioned load.

(15 marks)

Q.4(a) A linear DC machine has a constant flux-density of 0.5 Wb/m^2 directed into the page of the paper, a resistance of 0.25 Ω, a conductor bar of length 0.5 m, and a battery source of 120 V as shown in Figure Q.4(a).

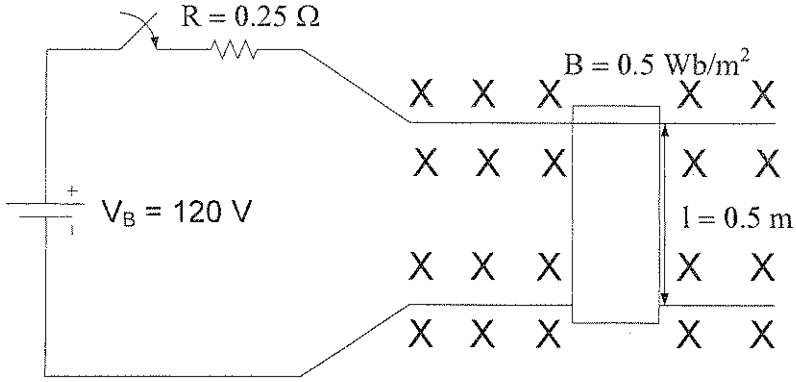

Figure Q.4(a)

(i) Initially assume that no load is applied on the bar, determine the corresponding no-load steady-state speed of the bar.

(3 marks)

(ii) If a load of 20 N is now applied on the bar in a direction opposite to the direction of motion, determine the corresponding new steady-state speed of the bar.

(5 marks)

(iii) If the supply voltage is now reduced to 100 V while keeping the flux-density at its original value, determine the corresponding new steady-state speed of the bar.

What conclusion can you draw from the observation in part (iii)?

(5 marks)

(b) A permanent magnet DC motor is directly and rigidly coupled to a load whose characteristic is given by

$$T_L = 5 + 0.05\omega + 0.001\omega^2$$

where T_L is in N.m, and ω is in rad/sec.

The motor has a back-emf constant of 2.42 V/(rad/s), the armature resistance is 0.2 Ω and the armature inductance is very small and can be neglected. The motor is supplied with a DC voltage of 50 V.

Determine the corresponding steady-state speed(s) of the motor.

(12 marks)

END OF PAPER