NATIONAL UNIVERSITY OF SINGAPORE

EXAMINATION FOR

(Semester I: 2010/2011)

EE1002 – INTRODUCTION TO CIRCUITS AND SYSTEMS

November/December 2010 - Time Allowed: 2.0 Hours

INSTRUCTIONS TO CANDIDATES:

1. This paper contains **FOUR** (4) questions and comprises **SIX** (6) printed pages.
2. Answer all **FOUR** (4) questions.
3. All questions carry equal marks.
4. This is a CLOSED BOOK examination.

Q.1 (a) The Wheatstone bridge circuit shown in Figure Q1(a) is used in determining the value of an unknown resistor R_x.

Find the value of R_x in terms of the voltage, $V_{ab} = V_a - V_b$, R, and V_s.

(4 marks)

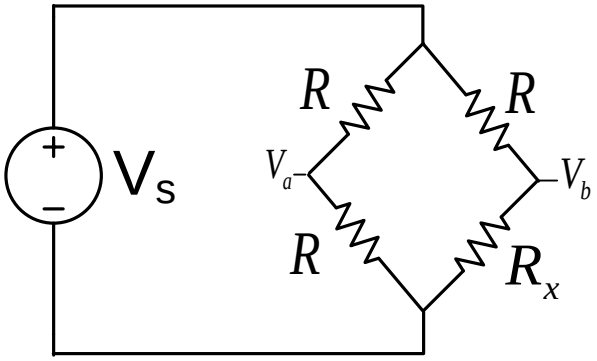

Fig. Q1(a)

(b) For the circuit given in Figure Q1(b), find the Norton equivalent circuit between *a* and *b*.

(8 marks)

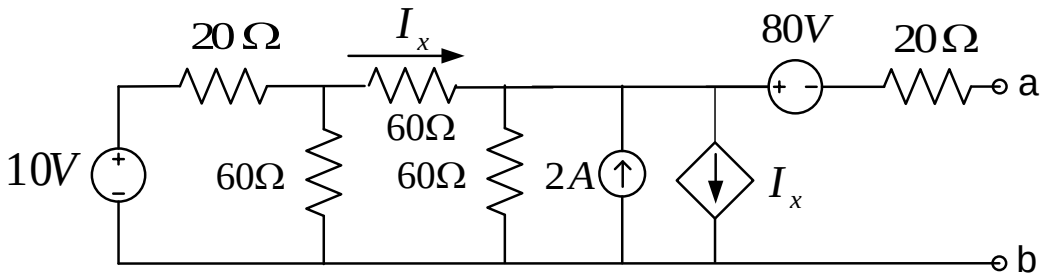

Fig. Q1 (b)

(c) In the Figure Q1 (c), the switch *S* was closed for very long time before it is opened at time $t = 0$.

i) Find the value of $v_c(t)$ and $i_L(t)$ at $t = 0^+$ i.e. immediately after the switch was opened.

(5 marks)

ii) Find the value of $v_c(t)$ and $i_L(t)$ at $t = \infty$.

(4 marks)

iii) Find the expressions for $v_c(t)$ and $i_L(t)$ after $t = 0$.

(4 marks)

Q.1 is continued on Page 3

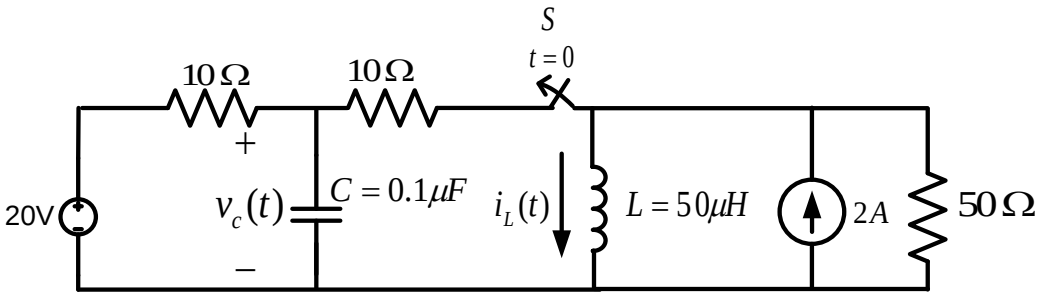

Fig. Q1 (c)

Q.2 (a) For the circuit given in Figure Q2(a), the time varying voltage and current sources are given as:

$$v_s(t) = 100\sin(100t)\,V \text{ and}$$
$$i_s(t) = 100\cos(100t)\,A.$$

Find the current $i(t)$.

(10 marks)

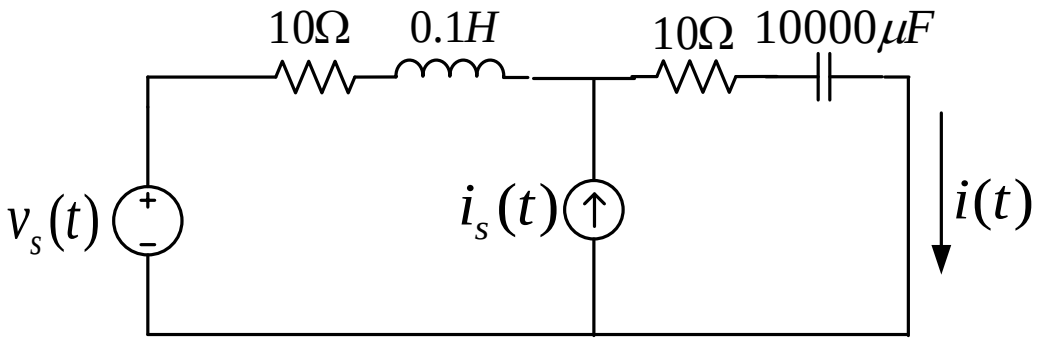

Fig. Q2 (a)

(b) In the circuit shown in Figure Q2(b), two loads A and B are connected to the source. The cable connecting the power supply to the load is modeled as series R and L of values $R = 0.1\Omega, L = 0.1\ mH$ as shown in the figure.

The loads have the following specifications:

Load A: 230V, 50Hz, 1kW, pf=0.5 lagging.

Load B: 230V,50Hz, 1kW, pf=0.87 lagging.

Q.2 is continued on Page 4

i) Find the series R-L equivalent of the two loads together.

(6 marks)

ii) Find the power factor as seen by the source.

(4 marks)

iii) Find the value of the capacitor to be connected across the source so that the source voltage and the total current drawn from it are in phase with each other.

(5 marks)

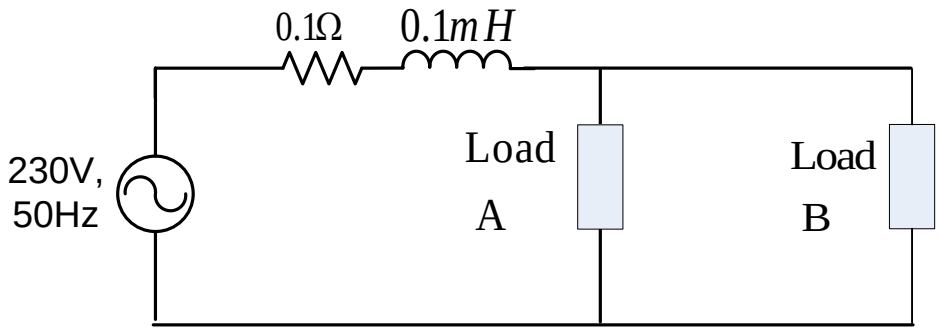

Fig. Q2 (b)

Q.3 (a) A coil shown in Fig. Q.3(a) has 250 turns and is wound on a **<u>silicon sheet steel</u>**. The inner and outer radii are 20 cm and 25 cm, respectively and the toroidal core has a circular cross section.

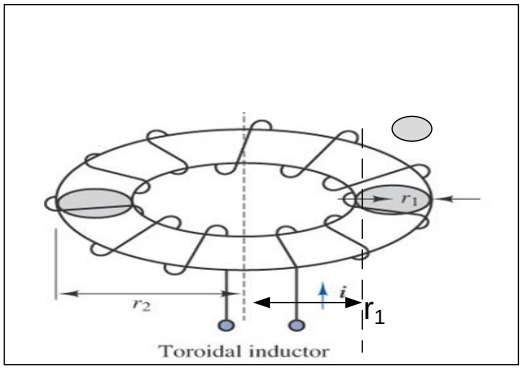

Fig. Q3(a)

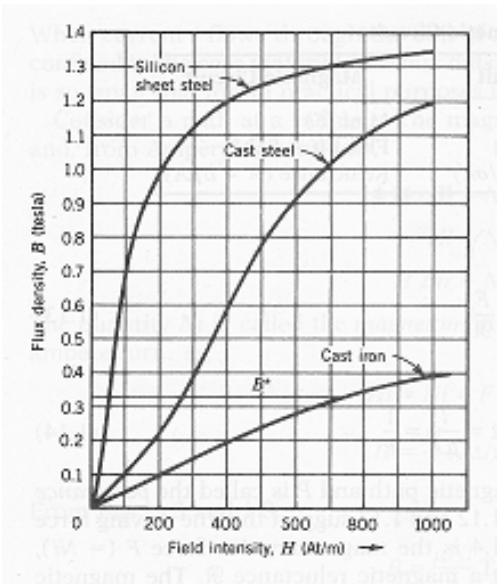

Fig. Q3(b)

Q.3 is continued on Page 5

For a coil current of 2.5 A.

(i) Determine the magnetic flux-density at the mean radius of the toroid.

(4 marks)

(ii) Determine the inductance of the coil, assuming that the flux-density within the core is uniform and equal to that at the mean radius.

(8 marks)

You may make use of the magnetization curve as shown in Fig. Q.3(b).

(b) A 200/400 V, 20 kVA, and 50 Hz transformer is connected as an auto-transformer to transform a 600 V ac supply voltage to match a 200 V ac voltage required by the load.

(i) Sketch the power circuit connection of the transformer showing the corresponding direction of the voltages and currents at different windings.

(3 marks)

(ii) If a load of 20 kVA, 0.8 p.f. lagging is connected to the 200 V terminals, determine the corresponding currents in the load and the transformer's two windings.

(10 marks)

Q.4 (a) A linear DC machine has a constant flux-density of 0.6 Wb/m^2 directed into the page of the paper, a resistance of 0.3 Ω, a conductor bar of length 1.0 m, and a battery voltage of 120 V as shown in Fig. Q4(a).

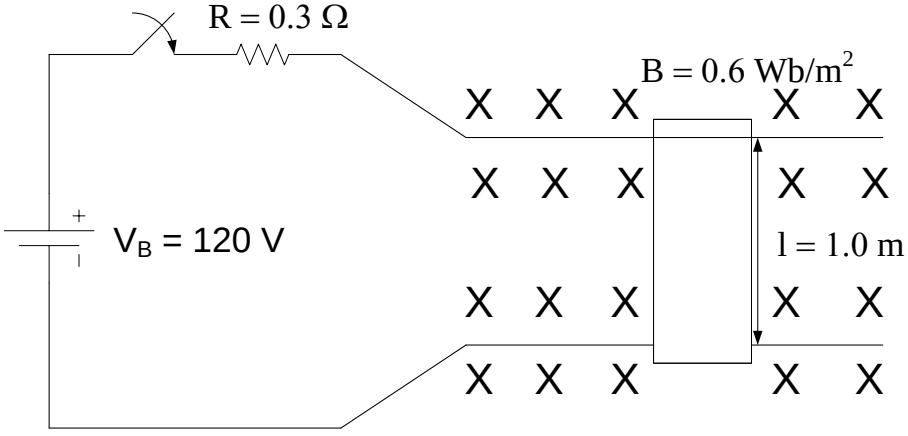

Fig. Q4(a)

Q.4 is continued on Page 6

(i) Determine the initial starting current and the corresponding induced force on the bar.

(3 marks)

(ii) Determine the no-load steady-state speed of the bar.

(3 marks)

(iii) If the bar is loaded with a force of 25 N opposite to the direction of motion, determine the corresponding new steady-state speed of the bar.

(3 marks)

(iv) Determine the efficiency of the machine for the operating condition as in part(iii).

(3 marks)

(b) A dc-shunt motor is being operated from a 300 V DC voltage source. At no-load, the machine operates at a speed of 1200 rpm. When the machine is loaded at rated load, it delivers a torque of 400 N.m and its speed drops to 1100 rpm.

Determine the motor speed and output power when delivering the rated torque and the motor is operated with an armature voltage of 600 V DC voltage source.

The field circuit is assumed to maintain the field current at the same value when excited from a 300 V DC voltage source. You may neglect the armature resistive voltage drop during no-load operation.

(13 marks)

END OF PAPER