NATIONAL UNIVERSITY OF SINGAPORE

EXAMINATION FOR

(Semester I: 2012/2013)

EE1002 – INTRODUCTION TO CIRCUITS AND SYSTEMS

November/December 2012 - Time Allowed: 2.0 Hours

INSTRUCTIONS TO CANDIDATES:

1. This paper contains **FOUR** (4) questions and comprises **SIX** (6) printed pages.

2. Answer all questions in **Section-A**. Answer **either** Q3(a) **or** Q3(b) and similarly **either** Q4(a) **or** Q4(b) **in Section-B**.

3. This is a CLOSED BOOK examination. The students may refer to the Formula Sheet given to them during the course of the examination.

SECTION-A: ANSWER ALL QUESTIONS IN THIS SECTION

Q.1 (a) Using the principles of superposition, find the current I in the circuit of Fig. Q1(a).

(10 marks)

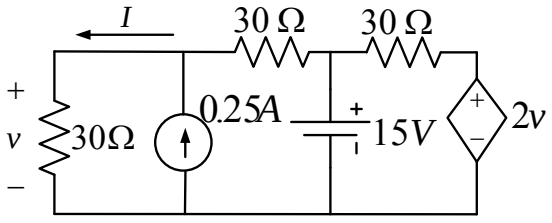
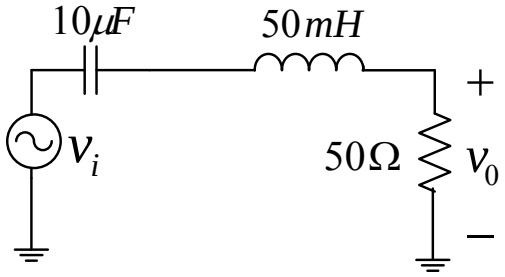


Fig. Q1(a)

(b) Write the expression for $v_o(t)$ shown in Fig. Q1(b).

(10 marks)



$$v_i(t) = 300\sin(1000t - 45^0)$$

Fig. Q1(b)

Q.2 (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 0.4 Ω, a conductor bar of length 1.0 m, and a battery voltage of 120 V as shown in Fig. Q2(a).

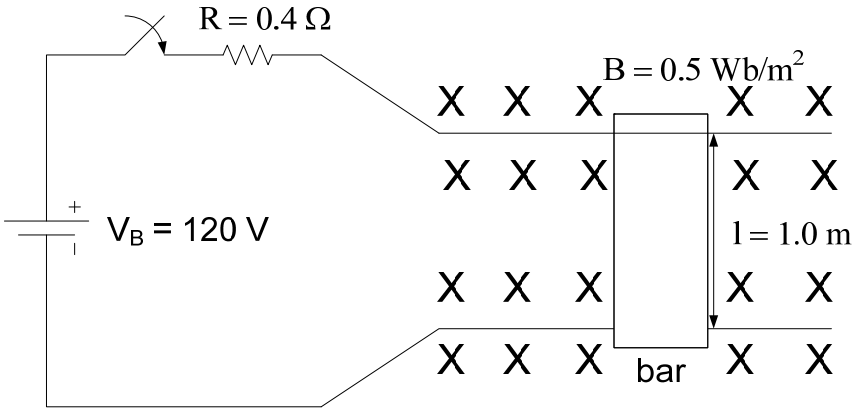


Fig. Q2(a)

(i) If no load is applied on the bar, determine the corresponding starting current and the force induced on the bar.

(3 marks)

(ii) Determine the corresponding steady-state speed of the bar.

(3 marks)

(iii) If a load of 25 N acting in a direction opposite to the motion of the bar is applied, determine the corresponding new steady-state speed of the bar.

(6 marks)

(iv) Determine the efficiency of the linear DC motor for the operating conditions in part (iii).

(3 marks)

Q.2 is continued on Page 4

(b) A toroid has a circular cross section as shown in Fig. Q2(b) and is made from a magnetic material with a relative permeability of 2500. Its outer radius is 12 cm and inner radius is 8 cm. The magnetic flux-density in the core is 1.25 wb/m^2 measured at the mean diameter of the toroid.

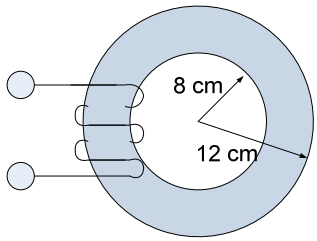


Fig. Q2(b) Magnetic circuit

(i) If the coil consists of 250 turns, applying Ampere's law determine the magnitude of the current that must be applied to the coil to produce a magnetic flux-density of 1.25 wb/m^2.

(3 marks)

(ii) Determine the corresponding magnetic flux in the core.

(5 marks)

(iii) A 10 mm air-gap is cut across the toroid shown in Fig. Q2(b). Determine the magnitude of the current that must be applied to the coil to produce the flux-density of 1.25 wb/m^2.

(7 marks)

END OF SECTION-A

SECTION-B: ANSWER EITHER Q3(a) or Q3(b) AND Q4(a) or Q4(b)

Q.3 (a) A 220 V DC shunt motor has the armature and field winding resistances of 0.15 Ω and 110 Ω, respectively. The motor draws a line current of 5 A from the DC voltage source while running on no-load. When driving at rated load, the motor runs at a speed of 1100 rpm and draws a current of 48 A of line current. Determine the no-load speed of the motor.

(20 marks)

OR

(b) A 10 kVA transformer has a constant core loss of 150 W and a full-load copper loss of 250 W.

Determine the transformer efficiency for the following load conditions:

(i) full-load at 0.8 power factor lagging and

(ii) 50% of full-load at unity power factor.

(20 marks)

Q.4 (a) Figure Q4(a) shows the schematic circuit of a TTL signal from a signal generator (in the dotted box) connected to an RC circuit. The internal resistor of the signal generator is 500 Ω. The TTL signal has a frequency of 500 Hz and 50% duty cycle.

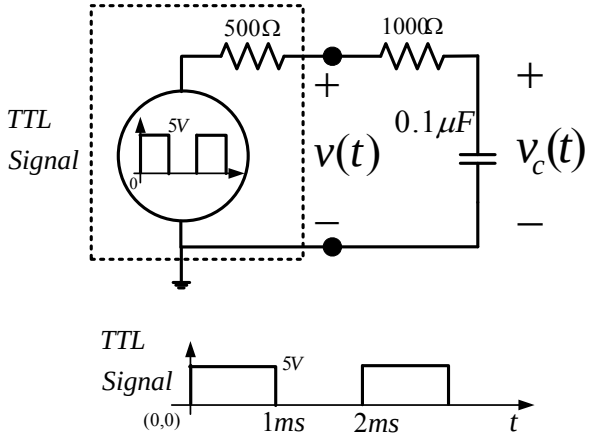


Fig. Q4(a)

Q.4(a) is continued on Page 6

Q.4(a) is continued from Page 5

(i) What are the values of $v(t)$ at the instant when the TTL signal changes from 0V to 5V and from 5V to 0V?

(5 marks)

(ii) Sketch and dimension the wave form of the voltage $v(t)$ for one cycle.

(5 marks)

(iii) Write the expression for voltage, $v_c(t)$ across the capacitor for one complete cycle of the TTL signal.

(10 marks)

(iv) If the TTL signal is changed to a sinusoidal signal of frequency 500Hz, what will be the phase difference between $v_c(t)$ and $v(t)$.

(10 marks)

OR

(b) The circuit in Figure Q4(b) shows two loads connected to a sinusoidal source of 230V rms and 50 Hz. Load-1 is of 1000W with a lagging power factor of 0.8. Load-2 is of 500W with a leading power factor of 0.75.

(i) Represent both the loads as series combinations of R and C or L. Calculate the values of R and L or C for each load.

(12 marks)

(ii) Find the value of the capacitor, which when connected in parallel to the loads, will improve the power factor to unity as seen by the source.

(13 marks)

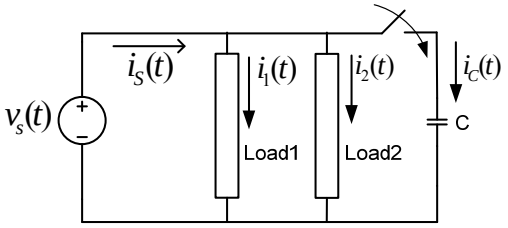


Fig. 4(b)

(iii) Draw the phasor diagram for quantities showing $v_s(t)$, $i_s(t)$, $i_1(t)$, $i_2(t)$ and $i_c(t)$.

(5 marks)

END OF SECTION-B

END OF PAPER