NATIONAL UNIVERSITY OF SINGAPORE

EXAMINATION FOR

(Semester II: 2011/2012)

CG1108 – ELECTRICAL ENGINEERING

April / May 2012 - Time Allowed: 2 Hours

INSTRUCTIONS TO CANDIDATES

1. This paper contains **FOUR (4)** questions and comprises **FIVE (5)** printed pages.
2. All questions are compulsory. Answer **ALL** questions.
3. This is a **CLOSED BOOK** examination.
4. Programmable calculators are not allowed.

Q.1 (a) Determine i_1, i_2, and i_3 in Fig. Q.1.a.

(10 marks)

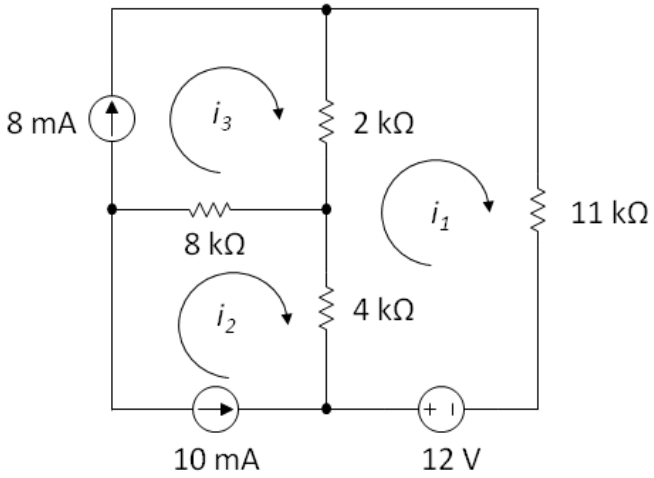


Fig. Q.1.a

(b) Solve for the voltages at Node 1 and Node 2, as shown in Fig. Q.1.b.

(10 marks)

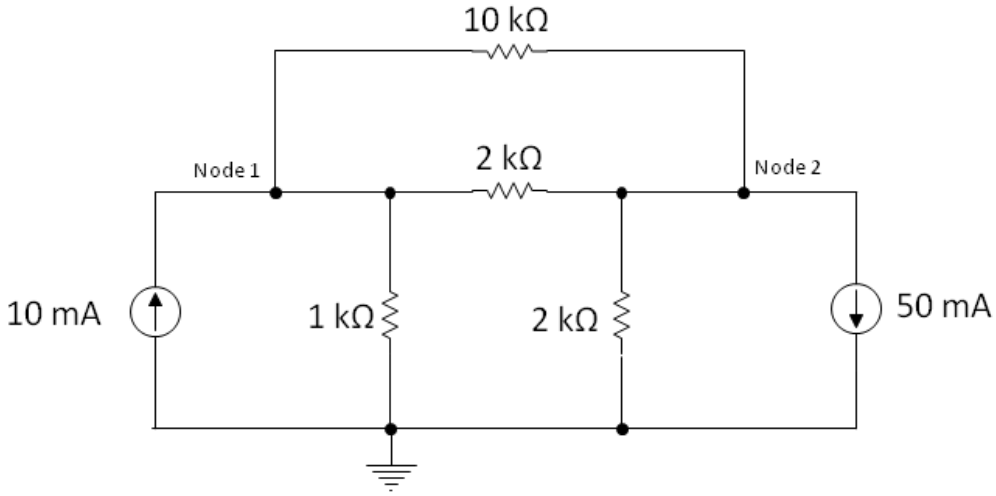


Fig. Q.1.b

Q.2 is continued on Page 3

Q.2 (a) The Wheatstone bridge circuit, as shown in Fig. Q.2.a, is a resistive circuit that is commonly used in measurement circuits. R_1, R_2, and R_3 are equivalent to 1 kΩ. Determine the unknown resistance R_x when V_{ab} is 10 mV.

(15 marks)

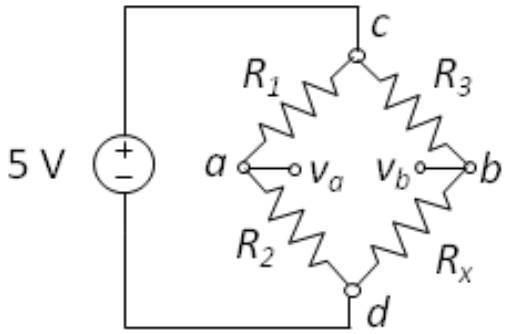


Fig. Q.2.a

(b) Determine the Thevenin's equivalent for the circuit in Fig. Q.2.b.

(15 marks)

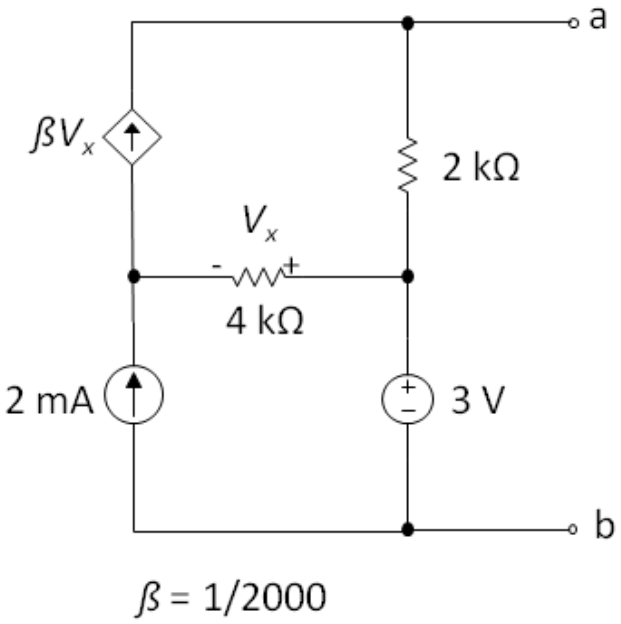


Fig. Q.2.b

Q.3 is continued on Page 4

Q.3 (a) As shown in Figure 3(a), the CMOS/TTL output of a signal generator is connected to an R-L circuit. The internal resistance of the signal generator is 200Ω.

Sketch and dimension the wave forms of the voltage at the output of the R-L circuit, for two cycles.

(12 marks)

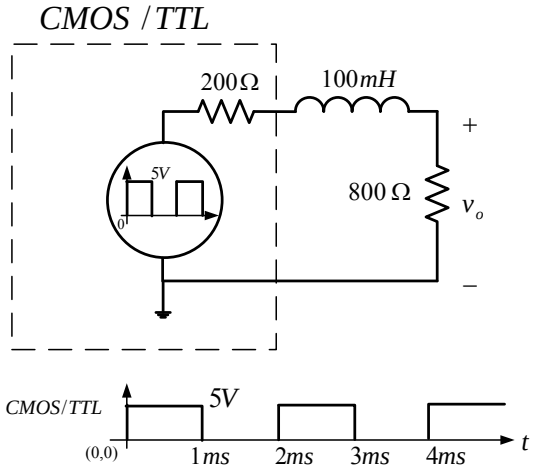


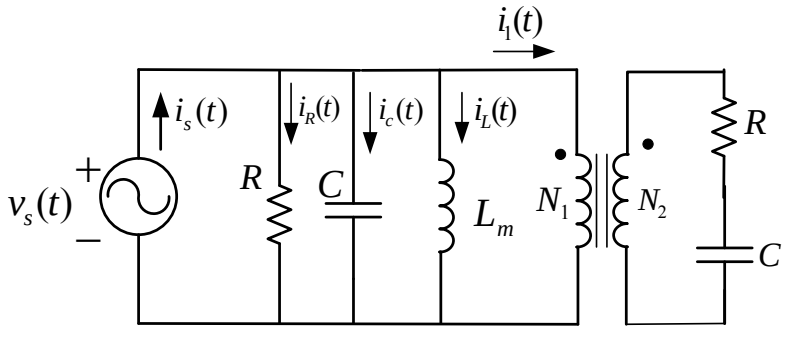
Fig. 3(a)

Q.3 (b) As shown in Figure 3(b), a voltage source is supplying an R-C load through a step-up ideal transformer. Also, a capacitive load and an inductive load are connected to primary side of the ideal transformer.

Find currents: $i_s(t), i_R(t), i_c(t), i_L(t), i_1(t)$ as shown in the figure.

Draw the phasor diagram for the source voltage $v_s(t)$ and all the currents: $i_s(t), i_R(t), i_c(t), i_L(t), i_1(t)$.

(13 marks)



$v_s(t) = 300 \cos \omega t$

$\omega = 300\ rad\ /\ s$

$L_m = 5mH$

$C = \frac{1}{900} F$

$R = 3\Omega$

$L = 5mH$

$N_1 = 100$

$N_2 = 200$

Fig. 3(b)

Q.4 (a) An autonomous vehicle has four sensors to track the line: Left (A), Left-Middle (B), Right-Middle (C) and Right (D). A warning LED lights up whenever the vehicle goes too much to the left or to the right (i.e. when three sensors on either side are off the line). The warning LED also lights up when all the sensors go off the line. The sensor circuit is such that when the sensor is off the line, it gives a 5V output; when it is on the line, then it gives 0V output.

i. Show the truth table with the sensors (A, B, C and D) as input and LED as the output.

(3 marks)

ii. Show the Karnaugh map for minimization.

(4 marks)

iii. Write the MPOS and MSOP expressions for the circuit.

(6marks)

(b) A permanent magnet DC motor (PMDC motor) is supplied from a rechargeable battery pack. Initially the battery pack is fully charged to open-circuit voltage of 7.2 V. The motor torque-speed characteristic with the fully charged battery pack is shown in Figure 4(b). Then, the starting torque for the motor $T_{m,start}$ is 2 mN-m (milli Newton-meter), and no-load speed $\omega_{m.,NL}$ is 72 rad/sec.

After being used for some time, the battery is partially discharged and has an open-circuit voltage output of 6V only. Also, the partially discharged battery pack has an internal resistance that is 10 Ohm more than when it is fully charged.

If the motor has to drive the load with 0.8 mN-m, what will be the steady-state speed when the motor is supplied from the partially discharged battery pack?

(12 marks)

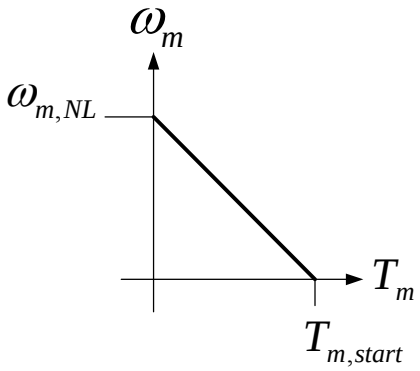


Fig 4(b)

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