Written exam
IE1206 Embedded Electronics
IF1330 Electrical principles
Friday 23/8 2019 14.00-18.00

General Information

Examiner: Carl-Mikael Zetterling

Responsible teacher at exam: Per-Erik Hellström 08-790 43 25

All sheets that are handed in need **your name and personal number** written on them.
Mark every sheet with the **problem it deals** with.
You cannot have more than one problem per sheet.

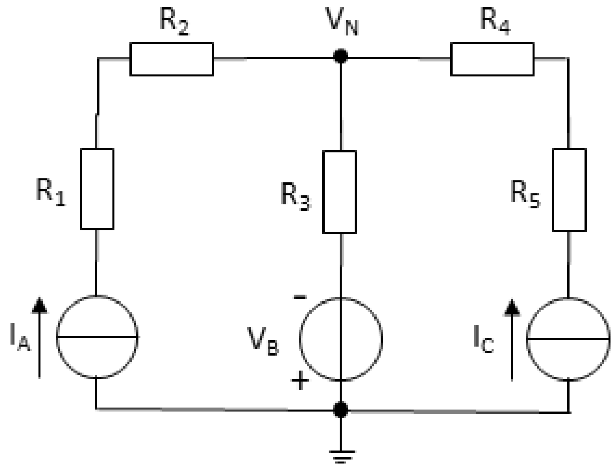
Aids: Calculator

The exam consists of 8 problems (5 points each) distributed over the 4 modules in the course:
Module 1: problem 1 and 2
Module 2: problem 3 and 4
Module 3: problem 5 and 6
Module 4: problem 7 and 8

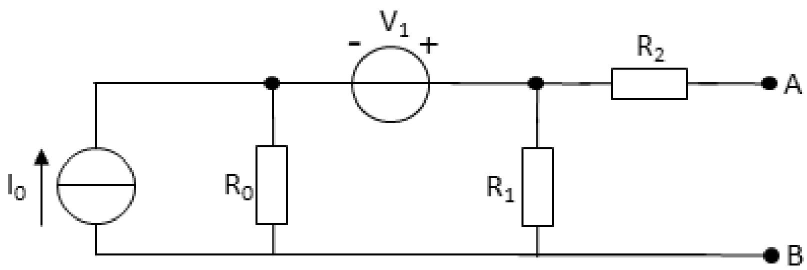
To **pass the exam** requires at least **2 points** from each module and preliminary **20 points** in total.
Grades are given as follows:

Points	<20	20-23	24-27	28-31	32-35	36-40
Grades	F	E	D	C	B	A

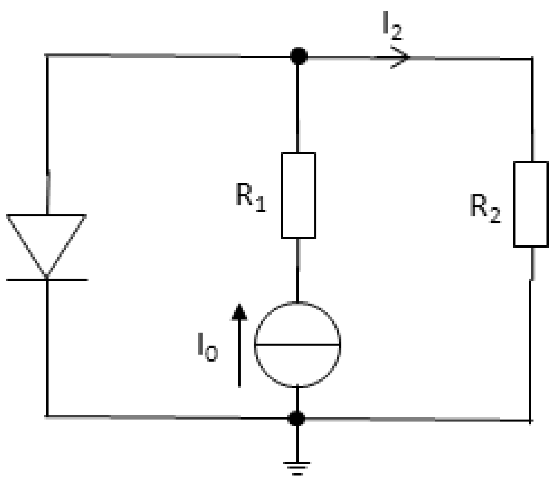
1. R_1=2 kΩ, R_2=3 kΩ, R_3=2 kΩ, R_4=3 kΩ, R_5=0.5 kΩ, I_A=1 mA, V_B=5 V , I_C=4 mA
   (A) Determine the voltage V_N.
   (B) What is the power consumed in R_3?



2. Determine the Thévenin equivalent circuit seen at A-B.
   I_0=3 mA, V_1=4 V, R_0=2 kΩ, R_1= 8 kΩ, R_2= 4 kΩ.



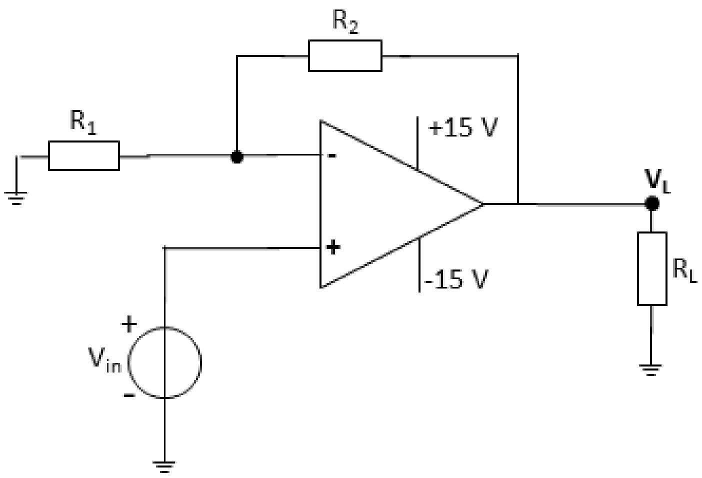
3. Determine the current I_2. The diode can be treated as an ideal diode with a threshold voltage V_T=0.7 V. I_0=500 µA, R_1=R_2=5 kΩ.



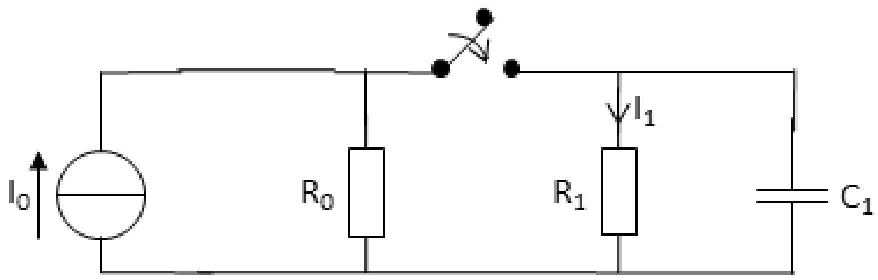
4. Assume that the operational amplifier is ideal. R_1=10 kΩ, R_2=30 kΩ and R_L=32 kΩ.

   (A) Determine the power dissipated in R_L when V_{in}=2 V.

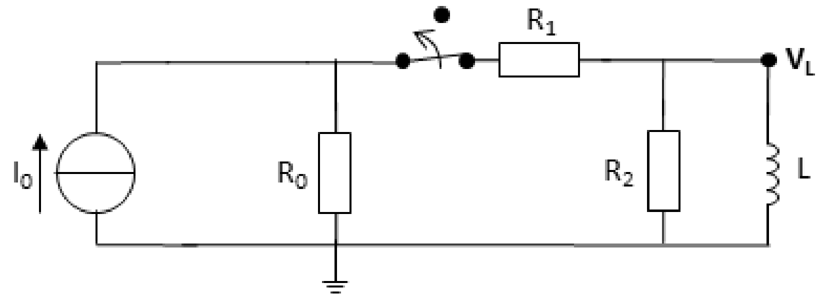
   (B) Determine V_L when V_{in}=5 V.



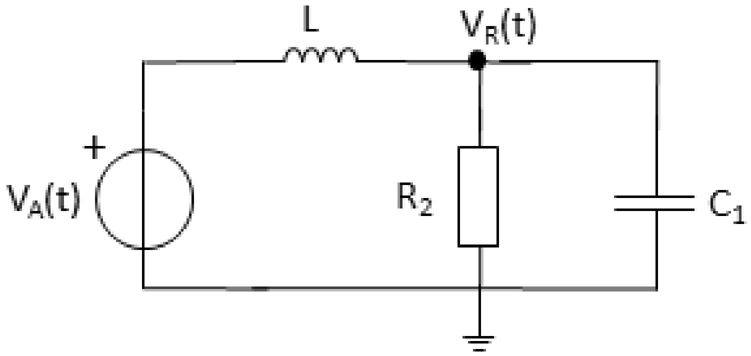
5. The switch has been open for a long time. At t=0 s the switch closes.
   (A) Derive an expression for $I_1(t)$ for t>0 s in terms of I_0, R_0, R_1 and C_1.
   (B) At what time t_1 is $I_1(t_1)$=1 mA assuming I_0=12 mA, R_0=1 kΩ, R_1=3 kΩ and C_1=20 nF.



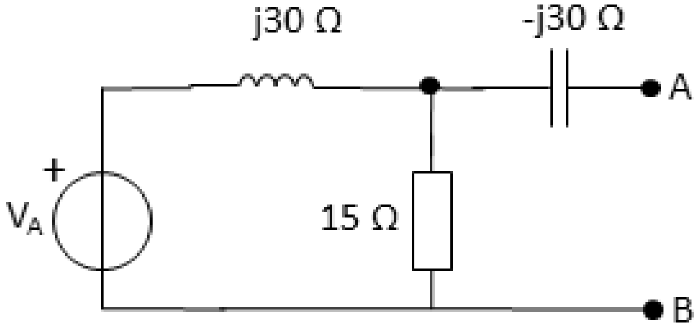
6. The switch has been closed for a long time. At t=0 s the switch opens.
   I_o=30 mA, R_0=1 kΩ , R_1=9 kΩ, R_2=10 Ω.
   Determine L so that V_L(t=1 ms) = 0.5V_L(t=0^+ s)



7. V_A(t) is a steady-state cosine voltage source with amplitude 2 V, angular frequency ω=10^6 rad/s and phase angle ϕ=0°. L=1 mH, R_2=1 kΩ and C_1=1 nF.
   Determine V_R(t).



8. (A) Determine the Norton equivalent circuit seen at A-B when V_A is a steady state cosine voltage source with amplitude=180 V and phase angle=90°.
   (B) Determine the components and their values and draw the Norton equivalent circuit when ω=1000 rad/s.



Answers to exam 20190823 in IE1206 and IF1330

1A: VN=5V

1B: PR3=50 mW

2: VTH=8 V, RTH=6.8 kOhm

3: I2=0.14 mA

4A: PRL=2 mW

4B: VL=15 V

5A: I1=Io*(R0/(R1+R0)*(1-exp(-t/tau)), tau=(R0//R1)*C1

5B: t1=6.1 µs

6: L=14.4 mH

7: VR(t)=2cos(wt-90) (or -pi/2)

8A: Ino=3j A, Zth=12-24j Ohm.

8B: In the scematic R=12 Ohm and C=41.6 µF and Ino=3cos(wt+90) (or pi/2)