KTH Informations- och kommunikationsteknik

Written exam
IE1206 Embedded Electronics
IF1330 Electrical principles
Friday 17/8 2018 08.00-12.00

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.

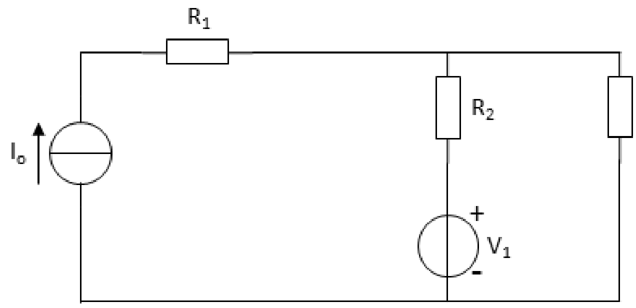
Aids: Calculator

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

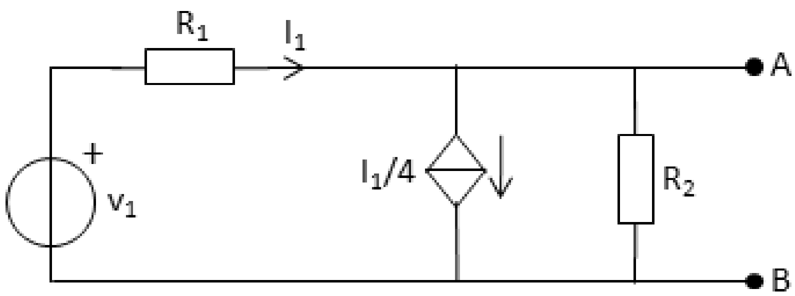
To **pass the exam** requires at least **2 points** from each module and preliminary **20 points** in total.
Grades are given as follows:

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

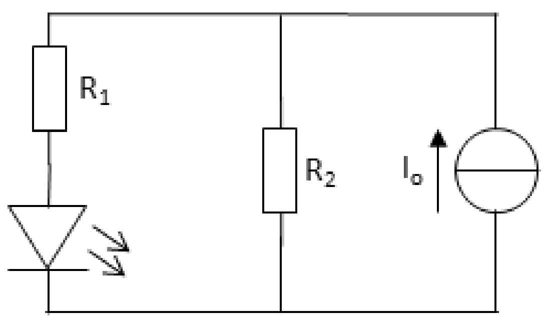
1. Determine the electrical power consumed in R_3.
   R_1=10 kΩ, R_2=0.4 kΩ, R_3=2 kΩ, V_1=3.2 V, I_o=7 mA.



2. Determine the Thevenin equivalent circuit seen at A-B.
   V_1=6 V, R_1=1.5 kΩ, R_2= 4 kΩ.



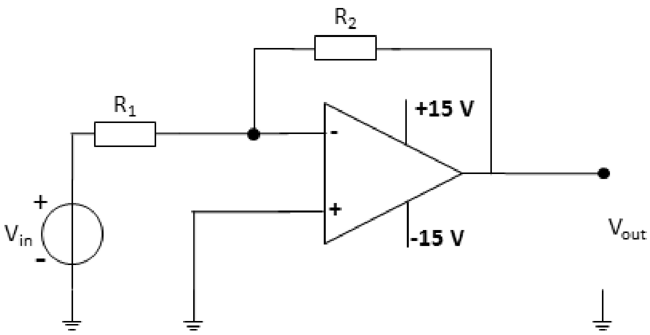
3. The light emitting diode (LED) has a threshold voltage V_T=2.0 V. R_1=1 kΩ and R_2=2 kΩ. Determine the current I_o needed to have a current of 1 mA flowing through the LED so that it emits light brightly.



4. Assume the operational amplifier is ideal.

   (A) Assuming operation in the linear region, derive an expression for V_{out} as a function of V_{in}, R_1 and R_2.

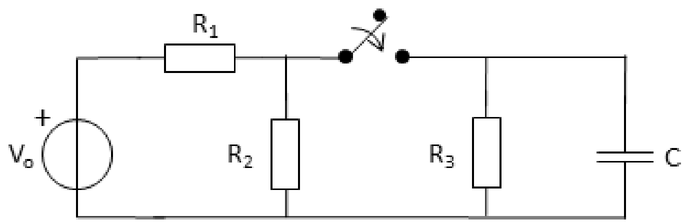
   (B) Whitin what voltage range must V_{in} be to assure that the operational amplifier operates in the linear region? R_1=1 kΩ and R_2=4 kΩ



5. In the circuit below V_o=3 V, R_1=1 kΩ, R_2=2 kΩ, R_3=3 kΩ and C=10 nF.

   (A) The switch has been open for a long time. Calculate the RC time constant for charging up (τ_{up}) the capacitor when the switch closes.

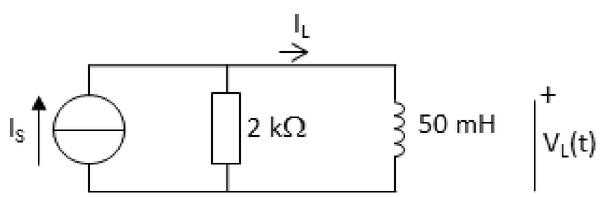
   (B) The switch has been closed for a long time. Calculate the RC time constant for discharging (τ_{down}) the capacitor when the switch opens.

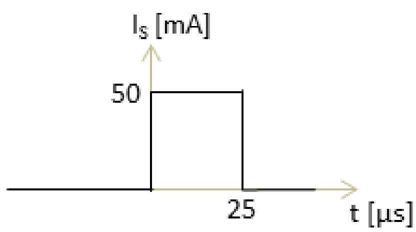


6. The current source in the circuit generates the current pulse shown in the figure below.

   (A) Derive a numerical expression for the voltage over the inductor, $V_L(t)$, in the interval 0<t<25 μs.

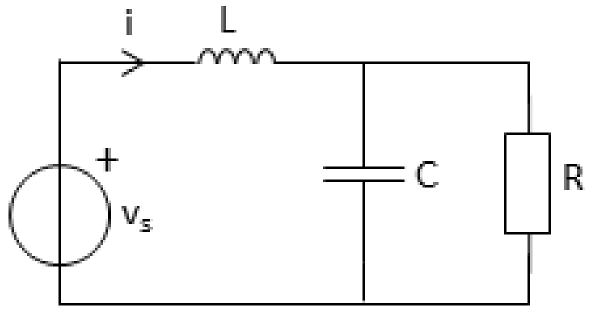
   (B) What is the energy stored in the inductor at t=25 μs?





7. (A) Derive an expression for the impedance (Z) as a function of the angular frequency (ω) seen by the voltage source v_s.

   (B) Determine i(t) when the steady-state voltage source $v_s=\sqrt{2}\cos(\omega t)$, L=1 H, ω=1000 rad/s, R=1 kΩ and C=1 μF.



8. $v_{in}(t)$ is a steady-state cosine voltage source with amplitude A and frequency ω.

   (A) Derive a complex expression for $\frac{\hat{V}_{out}}{\hat{V}_{in}}$ that include ω, R and L.

   (B) What type of filter function does the circuit perform? Motivate your answer.