KTH Informations- och kommunikationsteknik

Written exam
IE1206 Embedded Electronics
IF1330 Electrical principles
Friday 1/6 2018 08.00-12.00

General Information

Examiner: Carl-Mikael Zetterling

Responsible teacher at exam: Saul Rodriguez Duenas 076-118 84 80 or
Panos Chaourani 073-145 49 42

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

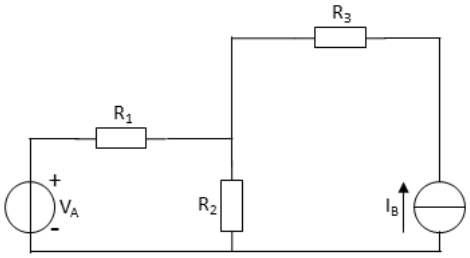
The exam consists of 8 problems (5 points each) distributed over the 4 modules in the course:
Module 1: problem 1 and 2
Module 2: problem 3 and 4
Module 3: problem 5 and 6
Module 4: problem 7 and 8

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

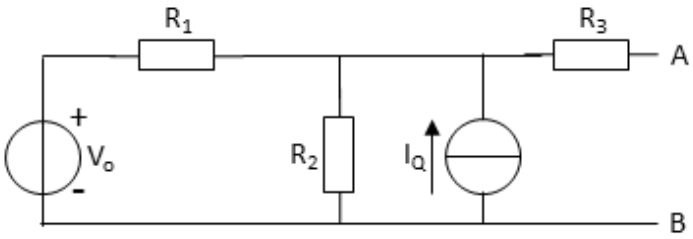
Points	<20	20-23	24-27	28-31	32-35	36-40
Grades	F	E	D	C	B	A

The result will be announced before Thursday 21/6 2018.

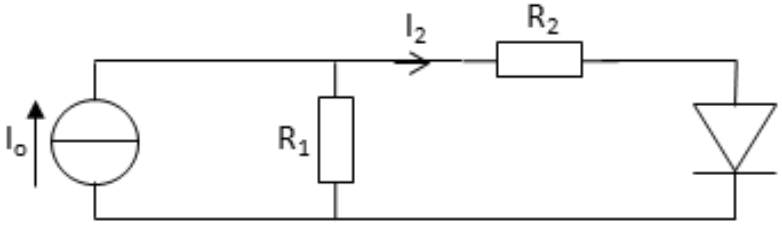
1. The electrical power consumed in R_2 is 9 mW. What is the power in the voltage source V_A?
   R_1=2 kΩ, R_2=1 kΩ, R_3= 10 kΩ, V_A=5 V, I_B= 2 mA.



2. Determine the Norton equivalent circuit seen at A-B.
   V_o= 6 V, R_1=40 kΩ, R_2= 40 kΩ, R_3= 5 kΩ, I_Q=0.1 mA.



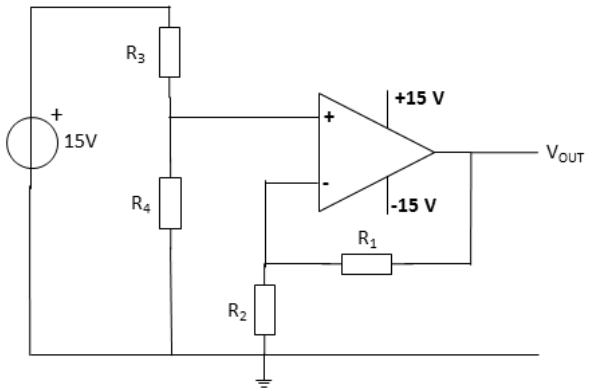
3. The Si diode has a threshold voltage V_T=0.7 V. I_o=2.05 mA, R_1= 10 kΩ, R_2= 2 kΩ.
   Determine the current I_2.



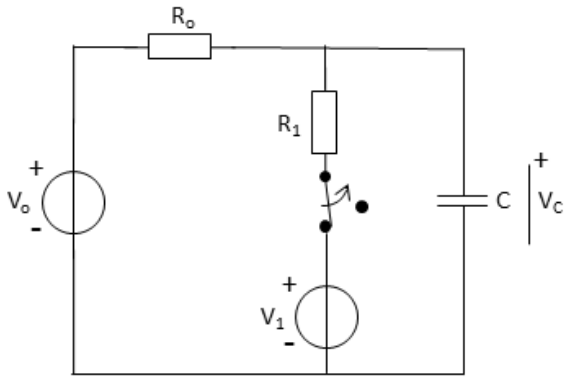
4. Assume the operational amplifier is ideal.
R_1=10 kΩ, R_2=5 kΩ, R_3=2 kΩ.

(A) Assuming operation in the linear region express V_{OUT} as a function of R_4.

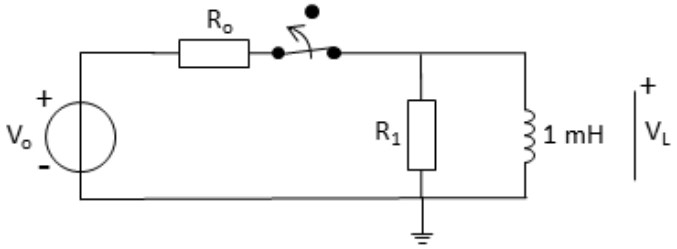
(B) What resistance values are allowed for R_4, be in order for the operational amplifier to operate in the linear region?



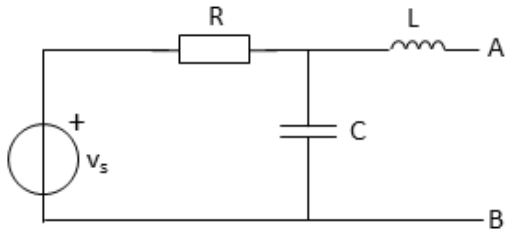
5. The switch has been closed for a long time. At t=0 s the switch opens.
Determine the voltage V_C over the capacitor at t=3 μs.
V_o=5 V, V_1=3 V, R_o=6 kΩ, R_1=3 kΩ, C=1 nF.



6. The switch has been closed for a long time. At t=3 μs the switch opens. Determine the time when the voltage V_L over the inductor is -5 V. V_o=10 V, R_o=1 kΩ, R_1=1 kΩ.



7. Determine the steady state Thevenin equivalent circuit seen at A-B. Express V_{TH} as a function of time. $v_s(t)=4\cos(\omega t+30°)$ V, $\omega = \sqrt{3}\cdot 10^6$rad/s. R=1 kΩ, C=1 nF, L=0.25 mH.

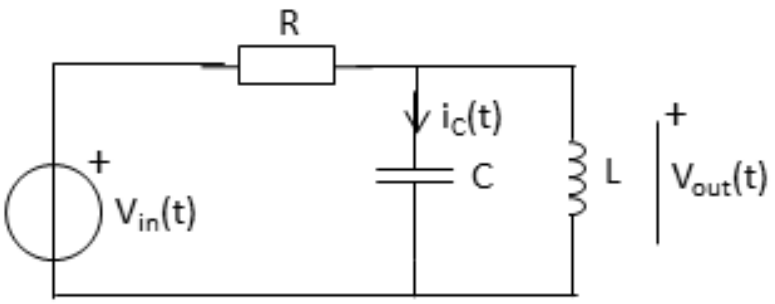


8. For the circuit below: $v_{in}(t)=10\cos(\omega t)$ V, R=10 kΩ, C=100 nF, L=10 μH

   (A) Is the circuit a band-pass or a band-reject filter? Motivate your answer.

   (B) Determine $v_{out}(t)$ at the resonance frequency $\omega_o = \sqrt{\frac{1}{LC}}$

   (C) What is the current $i_C(t)$ through the capacitor at the resonance frequency?



Answers to exam 20180601

1. Delivers 5mW

2. I_N= 0.2 mA R_{TH}= 25k ohm

3. I_2=1,65 mA

4. a)$V_{out} = 45(\frac{R_4}{R_4+2})$ unit of R_4 is kΩ

b) 0 < R_4 < 1 kOhm

5. V_C = 4.2 V

6. t=3.7 µs

7. V_{TH} =2cos(ωt - 30°) R_{TH} = 250 ohm

8.a) band pass,
b) 10 cos (ωt)
c) cos(ωt + 90°)