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
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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:

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<th>Points</th>
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<tr>
<td>Grades</td>
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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 $V_A$?
$R_1=2 \, k\Omega$, $R_2=1 \, k\Omega$, $R_3=10 \, k\Omega$, $V_A=5 \, V$, $I_B=2 \, mA$.

![Circuit Diagram]

2. Determine the Norton equivalent circuit seen at A-B.
$V_o=6 \, V$, $R_1=40 \, k\Omega$, $R_2=40 \, k\Omega$, $R_3=5 \, k\Omega$, $I_0=0.1 \, mA$.

![Circuit Diagram]

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

![Circuit Diagram]
4. Assume the operational amplifier is ideal.
R₁=10 kΩ, R₂=5 kΩ, R₃=2 kΩ.

(A) Assuming operation in the linear region express V_{OUT} as a function of R₄.

(B) What resistance values are allowed for R₄, 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 V₉ over the capacitor at t=3 µs. V₀=5 V, V₁=3 V, R₀=6 kΩ, R₁=3 kΩ, C=1 nF.
6. The switch has been closed for a long time. At $t=3 \mu s$ the switch opens. Determine the time when the voltage $V_L$ over the inductor is -5 V. $V_o=10$ V, $R_o=1 \, k\Omega$, $R_1=1 \, k\Omega$.

\[ V_L = 10 \, V, \quad R_o = 1 \, k\Omega, \quad R_1 = 1 \, k\Omega. \]

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

8. For the circuit below: $v_{in}(t)=10 \cos(\omega t) \, V$, $R=10 \, \text{k}\Omega$, $C=100 \, \text{nF}$, $L=10 \, \mu\text{H}$

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

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

(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}) \text{ unit of } R_4 \text{ is k\Omega}
   
   b) 0 < R_4 < 1 k\Omega

5. V_C = 4.2 V

6. t = 3.7 \mu s

7. V_{TH} = 2\cos(\omega t - 30^\circ) \quad R_{TH} = 250 \text{ ohm}

8. a) band pass,
   
   b) 10 \cos (\omega t)
   
   c) \cos(\omega t + 90^\circ)