SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Summer 2006
ENSC 320: ELECTRIC CIRCUITS II

Final Examination
August 17, 2006

Duration: 180 minutes. Attempt all four problems. Questions are **not** *equally weighted. Closed book and closed notes. Calculators, PDAs, laptops, and wireless phones are not permitted. Table of Laplace transforms is provided.*

1. **(20 points)**

   The circuits shown in Figure 1 is in equilibrium when the switch is closed at $t = 0$. Use the Laplace transform approach to find:

   - the capacitor voltage just before the switch is closed
   - voltage $v(t)$ for $t \geq 0$
   - voltage $v_c(t)$ for $t \geq 0$.
   - Verify your results by applying the initial-value and the final-value theorems.

2. **(30 points)**

   Consider the Sallen and Key circuit shown in Figure 2. Assume that the op-amp is ideal.

   - Find transfer function $H(s) = V_{out}/V_{in}$.
   - Find zeros and poles of $H(s)$.
   - If $Q = 1/\sqrt{2}$, find the magnitude and the phase of the frequency response.
   - Plot the magnitude and the phase as functions of ω.
   - Identify the type of the circuit.

3. **(30 points)**

   For the bandpass circuit shown in Figure 3, find:

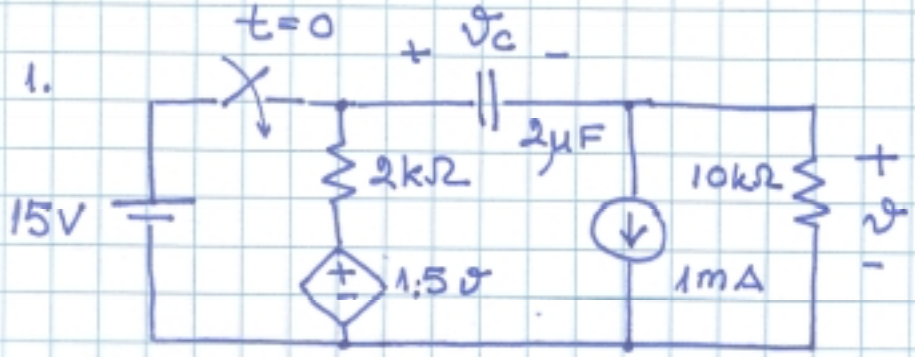
   - the transfer function $H(s) = I_L(s)/V_{in}(s)$
   - ω_m, H_m, and B_ω.

4. **(20 points)**

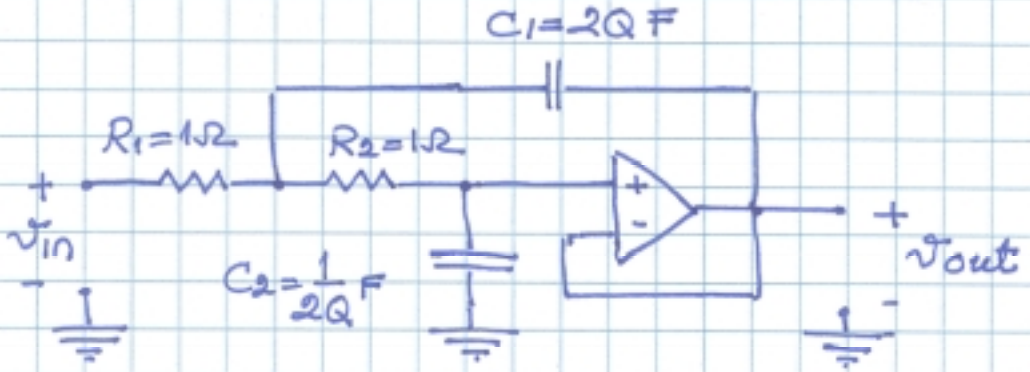
   Consider the circuit shown in Figure 4.

   - Compute the z-parameters.
   - Compute $Z_{in}(s)$.
   - If $v_1(t) = 10u(t)$ V, find $i_1(t)$.

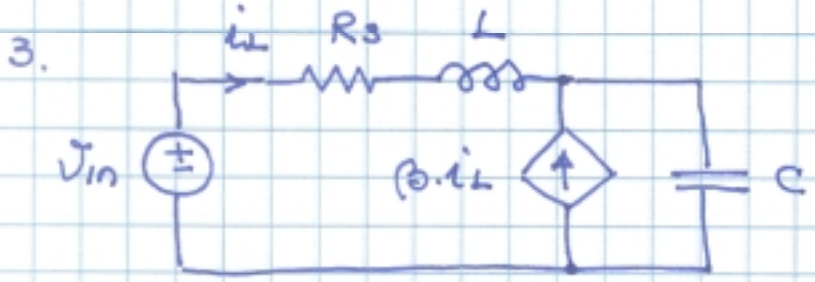
1.


t=0
+ ϑc −
2μF
2kΩ
10kΩ
15V
+
ϑ
−
1.5ϑ
1mA

2.


C1=2Q F
R1=1Ω
R2=1Ω
+
ϑin
−
C2=1/2Q F
+
ϑout
−

3.


iL
R3
L
ϑin
β·iL
C

4.

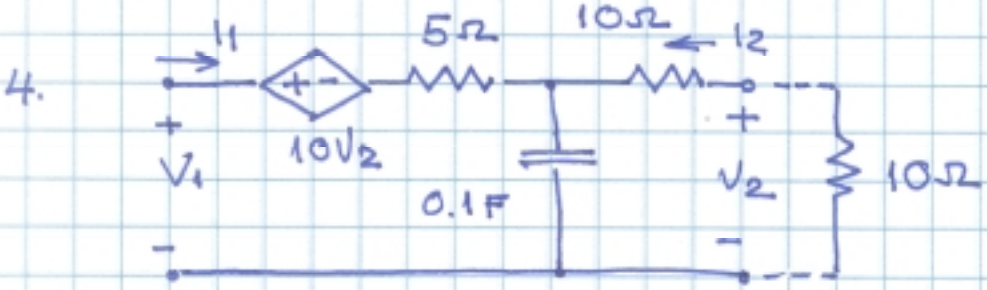

I1
5Ω
10Ω
I2
+
V1
−
10V2
0.1F
+
V2
−
10Ω

TABLE 13.1 Laplace Transform Pairs

Item number	$f(t)$	$\mathcal{L}[f(t)] = F(s)$
1	$K\delta(t)$	K
2	$Ku(t)$ or K	$\frac{K}{s}$
3	$r(t)$	$\frac{1}{s^2}$
4	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5	$e^{-at}u(t)$	$\frac{1}{s+a}$
6	$te^{-at}u(t)$	$\frac{1}{(s+a)^2}$
7	$t^n e^{-at}u(t)$	$\frac{n!}{(s+a)^{n+1}}$
8	$\sin(\omega t)u(t)$	$\frac{\omega}{s^2+\omega^2}$
9	$\cos(\omega t)u(t)$	$\frac{s}{s^2+\omega^2}$
10	$e^{-at}\sin(\omega t)u(t)$	$\frac{\omega}{(s+a)^2+\omega^2}$
11	$e^{-at}\cos(\omega t)u(t)$	$\frac{s+a}{(s+a)^2+\omega^2}$
12	$t\sin(\omega t)u(t)$	$\frac{2\omega s}{(s^2+\omega^2)^2}$
13	$t\cos(\omega t)u(t)$	$\frac{s^2-\omega^2}{(s^2+\omega^2)^2}$
14	$\sin(\omega t+\phi)u(t)$	$\frac{s\sin(\phi)+\omega\cos(\phi)}{s^2+\omega^2}$
15	$\cos(\omega t+\phi)u(t)$	$\frac{s\cos(\phi)-\omega\sin(\phi)}{s^2+\omega^2}$
16	$e^{-at}[\sin(\omega t)-\omega t\cos(\omega t)]u(t)$	$\frac{2\omega^3}{[(s+a)^2+\omega^2]^2}$
17	$te^{-at}\sin(\omega t)u(t)$	$2\omega\frac{s+a}{[(s+a)^2+\omega^2]^2}$
18	$e^{-at}\left[C_1\cos(\omega t)+\left(\frac{C_2-C_1a}{\omega}\right)\sin(\omega t)\right]u(t)$	$\frac{C_1 s+C_2}{(s+a)^2+\omega^2}$
19	$2\sqrt{A^2+B^2}\,e^{-at}\cos\left[\omega t-\tan^{-1}\left(\frac{B}{A}\right)\right]$	$\frac{A+jB}{s+a+j\omega}+\frac{A-jB}{s+a-j\omega}$
20	$2\sqrt{A^2+B^2}\,te^{-at}\cos\left[\omega t-\tan^{-1}\left(\frac{B}{A}\right)\right]$	$\frac{A+jB}{(s+a+j\omega)^2}+\frac{A-jB}{(s+a-j\omega)^2}$