SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2008
ENSC 320: ELECTRIC CIRCUITS II

Midterm Examination No. 2
March 19, 2008

Duration: 50 minutes. Attempt all four problems. Questions are **not** *equally weighted. Closed book and closed notes. Calculators, PDAs, laptops, and wireless phones are not permitted.*

1. **(25 points)** Consider the circuits shown in Fig. 1, where $R_1 = 50\ \Omega$, $R_2 = 200\ \Omega$, and $C = 2.5\ mF$.

   - Find its transfer function.
   - Let $v_{in}(t) = 10e^{-2t}u(t)\ V$ and $v_c(0_-) = 4\ V$.
     - Use Laplace transform to find the complete response of the circuit by first finding the zero-state response and the zero-input response.
     - Identify the circuit's forced response and natural response.
     - Identify the circuit's steady-state response and transient response.

2. **(40 points)**

   Consider the 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 $H(s)$.
   - Find the magnitude and the phase of the frequency response.
   - Plot the magnitude as functions of ω and identify the type of the circuit.

3. **(20 points)** Consider the circuits shown in Fig. 3, where $R = 0.25\ \Omega$ and $C = 1\ F$.

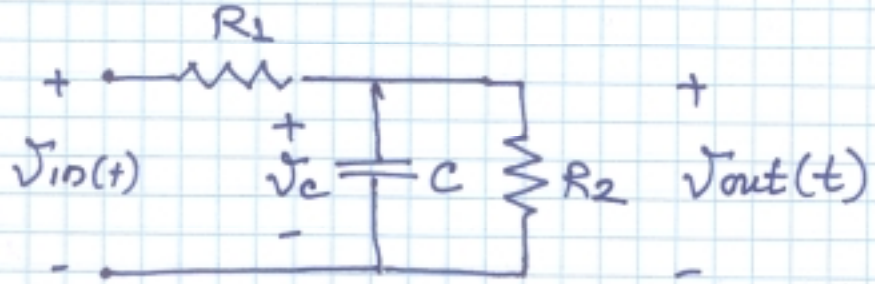
   - Find the transfer function $H(s)$ and the impulse response $h(t)$.
   - If $i_{in}(t) = 3e^{-t}u(t)\ A$, find $v_c(t)$ using the convolution integral.

4. **(15 points)**

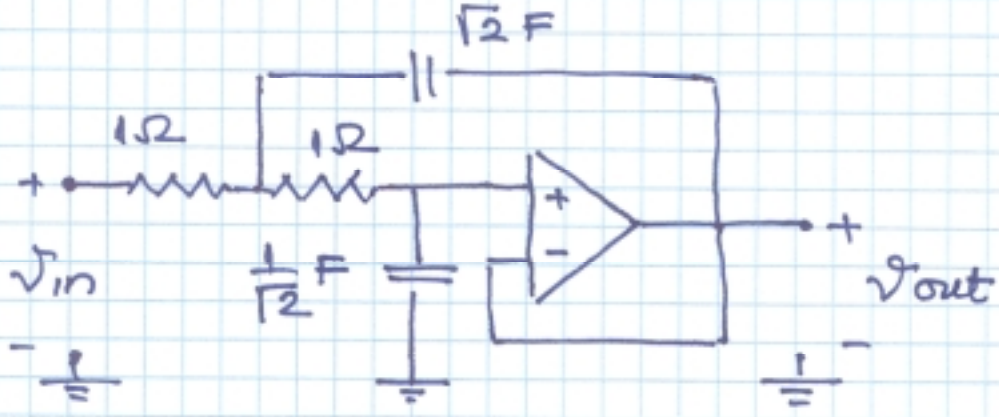
   Consider the circuit shown in Figure 4. Find:

   - input impedance $Z(s)$
   - the circuit's resonant frequency ω_r
   - input impedance at ω_r.

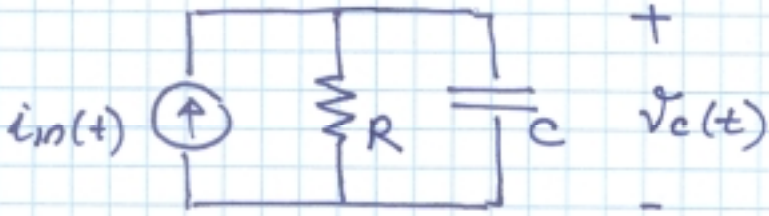
1)


R1
+
$v_{in}(t)$
-
+
v_c
-
C
R_2
+
$v_{out}(t)$
-

2)


$\sqrt{2}$ F
1Ω
1Ω
+
v_{in}
-
$\frac{1}{\sqrt{2}}$ F
+
-
+
v_{out}
-

3)


$i_{in}(t)$
R
C
+
$v_c(t)$
-

4)

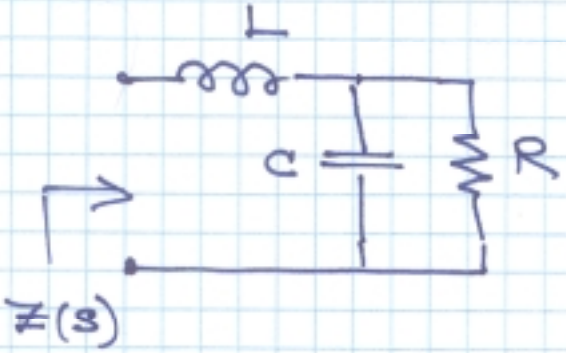

L
C
R
$Z(s)$

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	$2\sqrt{A^2+B^2}\,te^{-at}\cos\left[\omega t-\tan^{-1}\left(\frac{B}{A}\right)\right]$	$\frac{A+jB}{(s+a+j\omega)^2}+\frac{A-jB}{(s+a-j\omega)^2}$