SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Spring 2008
ENSC 320: ELECTRIC CIRCUITS II

Final Examination
April 15, 2008

Duration: 3 hours. Attempt all four problems. Questions are **not** *equally weighted. Closed book and closed notes. Calculators, PDAs, laptops, and wireless phones are not permitted.*

1. **(30 points)** The ideal op amp circuit shown in Figure 1 has initial capacitor voltages $v_{c1}(0_-) = 2\ V$ and $v_{c2}(0_-) = 0\ V$. Circuit parameters are: $R_1 = 2.5\ k\Omega$, $R_2 = 5\ k\Omega$, $C_1 = 0.2\ mF$, and $C_2 = 0.2\ mF$.

   - Construct the Laplace transform domain equivalent circuits, accounting for these initial conditions.
   - Find $V_{out}(s)$.
   - Find $v_{out}(t)$ for $t \geq 0$.
   - Make a rough sketch of the response.

2. **(30 points)** For the circuit shown in Figure 2:

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

3. **(20 points)** For the circuit shown in Figure 3, $R = 1\ \Omega$, $L_1 = 2\ H$, $L_2 = 10\ H$, $M = 2\ H$, and $C = 0.8\ mF$.

   - Find $Z_{in}(s)$
   - Find the value of ω at which resonance occurs.

4. **(20 points)** Consider the circuit shown in Figure 4.

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

Figure 1.

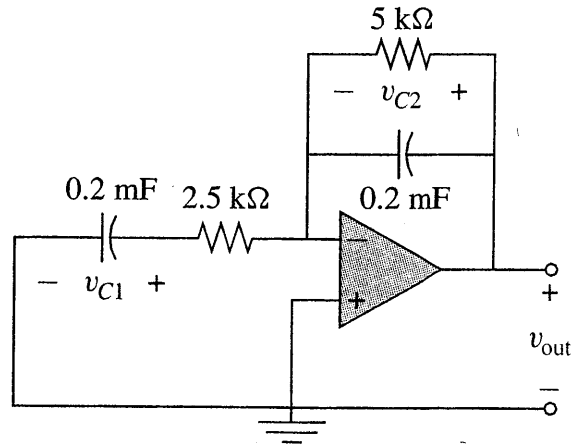

Figure 2.

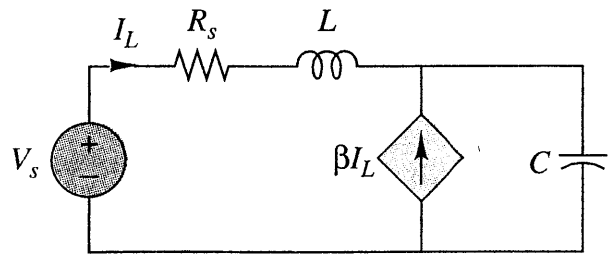

Figure 3.

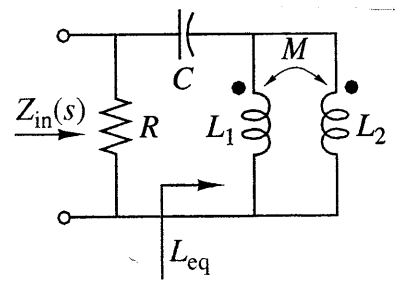

Figure 4.

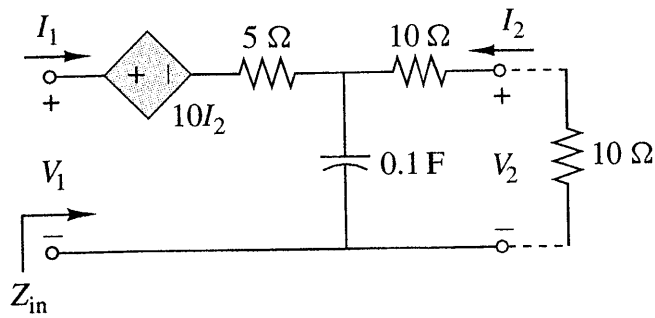

TABLE 13.1 Laplace Transform Pairs

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