SIMON FRASER UNIVERSITY
SCHOOL OF ENGINEERING SCIENCE

Summer 2007
ENSC 320: ELECTRIC CIRCUITS II

Final Examination
August 16, 2007

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

1. **(20 points)** For the ideal op amp circuit shown in Figure 1:
   - Find the transfer function and the poles and the zeros in terms of R_1, R_2, C_1, and C_2.
   - Find the impulse response.

2. **(20 points)**

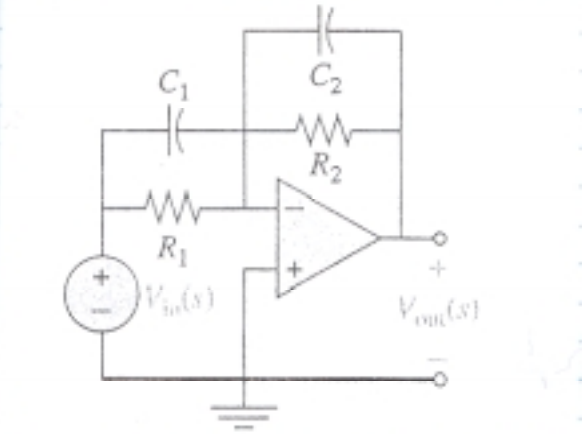
   For the circuit shown in Figure 2:
   - Find the value of C that makes the circuit resonant at $\omega = 3\ rad/s$.
   - Find the value of Y_{in} at the resonant frequency.
   - Is the circuit stable? Please justify your answer.

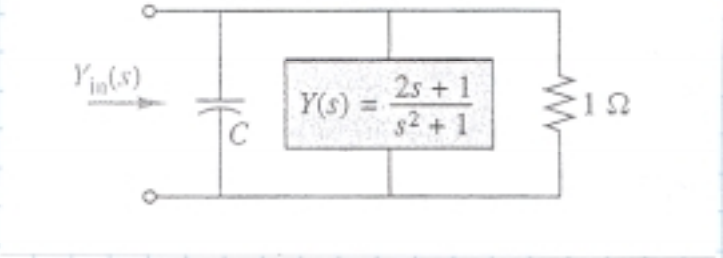
3. **(40 points)**

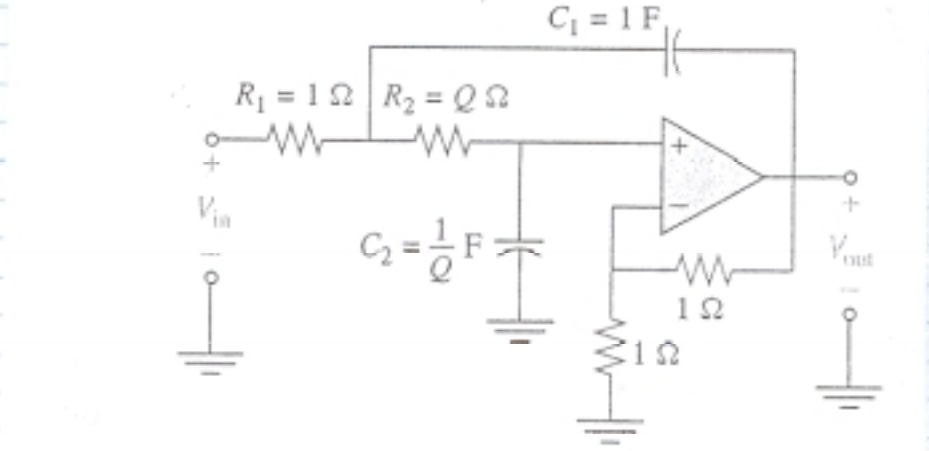
   Consider the Sallen and Key circuit shown in Figure 3. Assume that the op-amp is ideal.
   - Find transfer function $H(s) = V_{out}/V_{in}$.
   - Find the zeros and the poles of $H(s)$.
   - Find the magnitude and the phase of the frequency response.
   - Identify the type of this circuit.

4. **(20 points)**

   Consider the circuit shown in Figure 4.
   - Compute the y-parameters of the boxed two-port.
   - Compute the input admittance $Y_{in}(s)$ of the complete circuit.


C_1
C_2
R_2
R_1
$V_{in}(s)$
$V_{out}(s)$


$Y_{in}(s)$
C
$Y(s) = \frac{2s+1}{s^2+1}$
1 Ω


$C_1 = 1$ F
$R_1 = 1\ \Omega$
$R_2 = Q\ \Omega$
V_{in}
$C_2 = \frac{1}{Q}$ F
V_{out}
1 Ω
1 Ω

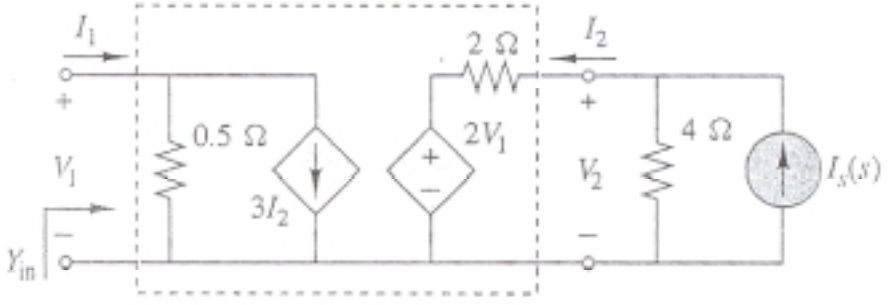

I_1
I_2
2 Ω
0.5 Ω
$2V_1$
4 Ω
V_1
$3I_2$
V_2
$I_s(s)$
Y_{in}

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