Electronic Circuits: Final Examination

10:20~12:00, 1/13/2006

1. **(14%)** Suppose a feedback resistor R_F is connected from the upper input terminal to the upper output terminal of the amplifier circuit in Fig. 1. Find $R_i' = v_{in} / i_{in}$ and $A_v = v_{out} / v_s$ (expressed as a function of other parameters).

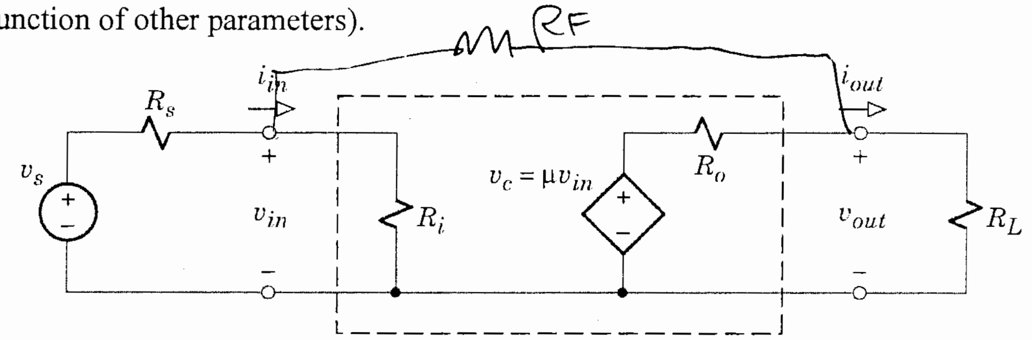

Fig. 1

2. **(16%)** Let $R = 3\Omega$ and $i_s = 4\text{A}$ in Fig. 2. Use node analysis to calculate v_1, v_2, i_1, and i_2.

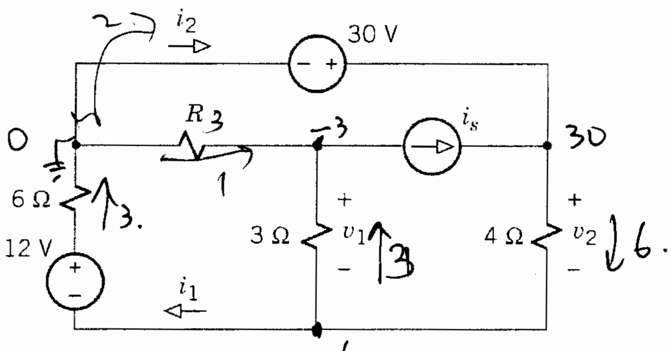

Fig. 2

$\frac{1}{3}(v_2 - v_1) + \frac{v_2}{6} = \frac{1}{4}(30 - v_2)$

-2

3. Consider the circuit in Fig. 3.

   (a) **(10%)** Derive the parameters a, b, c, and d, e, f, in terms of C, R, L:

$$\begin{cases} i_L'' + a i_L' + b i_L = c i_S \\ v_C'' + d v_C' + e v_C = f i_S' \end{cases}$$

$-2k_1 e^{-2t} \cos 4t \quad -2k_2 e^{-2t} \sin$

$-4k_1 e^{-2t} \sin 4t \quad 4k_2 e^{-2t} \cos$

   (b) **(10%)** Find the step response of $i_L(t)$ when $i_S = 3u(t)$, $C = \frac{1}{40}\text{F}$, $R = 10\Omega$, and $L = 2\text{H}$.

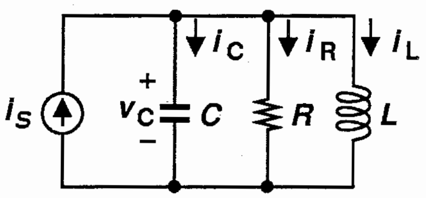

Fig. 3

$$\begin{bmatrix} 8 & -4 \\ -4 & 9 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} -48 \\ 66 \end{bmatrix}$$

$(x+2)^2 + 16$

NOTE: There are problems in the back.

$\Delta = 72 - 16 = 56$

$D_1 = -168$

$D_2 = 336$

$v_2 = 6$

$v_1 = -3$

$-2 \pm 4i$

4. **(5%)** Consider the circuit in Fig. 4, and find the transfer function of $\dfrac{V_{out}}{V_{in}}$.

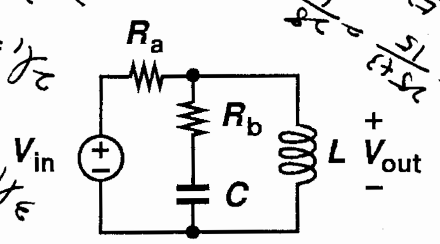

Fig. 4

5. **(10%)** Draw the asymptotic Bode Plot (both the gain and phase) of $H(s) = \dfrac{8000s}{(s+10)(s+40)}$.

6. **(20%)** Consider a circuit described by $\dfrac{d^2 i}{dt^2} + 4\dfrac{di}{dt} + 3i = x$. Find the complete response $i(t)$ for $t > 0$, when $x(t) = 5$ for $t < 0$, and $x(t) = \sin t$ for $t > 0$. Please feel free to use $\times$, $|\ |$, $\sqrt{\ }$ and $\tan^{-1}$ wherever appropriate.

7. **(15%)** Given $F(s) = \dfrac{2s^2+5}{(s-3)(s^2+4s+40)}$, find the corresponding time-domain function $f(t)$ via inverse Laplace transform. Also find $f(\infty)$ using the final-value theorem, or explain why the theorem is not applicable. Please feel free to use $\times$, $|\ |$, $\sqrt{\ }$ and $\tan^{-1}$ wherever appropriate.