國立高雄大學九十四學年度轉學招生考試試題

系所組別：電機工程學系　　科目：工程數學

考試時間：90 分鐘　　本科原始成績滿分 100 分

微分方程 50%

請按試題順序作答

DE.1.(10%). $y''+5y'+6y = 4te^{-2t} + e^{-2t}$

Solve $y(t)$.

DE.2.(10%) Find the Laplace transform (L) of the followings

$\mathrm{L}\{\sinh(k \cdot t)\}$

$\mathrm{L}\{e^{at} \cdot \sin(k \cdot t)\}$

DE.3.(15%)

$y''+4y'+13y = 0$

$y(0) = 1$

$y'(0) = 1$

Solve $y(t)$.

DE.4.(15%)

$f(x) = x(\pi - x)$

$0 \le x < \pi$

Find the Fourier series of the odd extension.

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線性代數 50%

1. Determine whether the following are subspaces of $R^{2\times 2}$.

10% (a) The set of all 2×2 diagonal matrices
(b) The set of all 2×2 triangular matrices
(c) The set of all 2×2 matrices A such that $a_{12} = 1$
(d) The set of all 2×2 matrices B such that $b_{11} = 0$
(e) The set of all symmetric 2×2 matrices

2. Find the best quadratic least squares fit to the data

10%

x	0	1	2	3
y	3	2	4	4

3. Let

10%

$$A = \begin{bmatrix} 3 & -1 & -2 \\ 2 & 0 & -2 \\ 2 & -1 & -1 \end{bmatrix}$$

factor the matrix A into a product XDX^{-1}, where D is diagonal.

4. Let

10%

$$A = \begin{bmatrix} 1 & -1 & 4 \\ 1 & 4 & -2 \\ 1 & 4 & 2 \\ 1 & -1 & 0 \end{bmatrix}$$

Find an orthonormal basis for the column space of A.

5. Let $E = [\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3]$ and $F = [\mathbf{b}_1, \mathbf{b}_2]$, where

10%

$$\mathbf{u}_1 = (1, 0, -1)^T, \quad \mathbf{u}_2 = (1, 2, 1)^T, \quad \mathbf{u}_3 = (-1, 1, 1)^T$$

and

$$\mathbf{b}_1 = (1, -1)^T, \quad \mathbf{b}_2 = (2, -1)^T$$

For each of the following linear transformations L from R^3 into R^2, find the matrix representing L with respect to the ordered bases E and F.

(a) $L(\mathbf{x}) = (x_3, x_1)^T$　　(b) $L(\mathbf{x}) = (x_1 + x_2, x_1 - x_3)^T$

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1. (20%)
Two inductive loads are connected in parallel with a 600-V source. The power and current drawn by each load are:

$$P_1 = 23kW \qquad |I_1| = 150A$$
$$P_2 = 60kW \qquad |I_2| = 200A$$

(a) Find the complex power and rms current supplied by the source, and calculate the power factor of the combined loads.
(b) A capacitor is now added in parallel, increasing the power factor to 0.9 lagging. Find the current drawn from the source and the capacitor's reactive power.

2. (20%)
Let the circuit in Fig. 1 have $v_s = 12V$, $i_c = 2i_x$, $v_c = 6\Omega \times i_z$, and $R = 3\Omega$.
(a) Use node analysis to form and solve the matrix node equation for v_1 and v_2.
(b) Calculate i_1, i_2, and the equivalent input resistance $R_{eq} = v_s / i_1$.

3. (20%)
Given the asymptotic gain curve of a circuit in Fig. 2(a), then
(a) find the corresponding transfer function $H(s)$.
(b) design an op-amp circuit by using the fundamental circuits in Fig. 2(b) to get the transfer function $H(s)$. (Let all capacitors be $0.25\mu F$)

4. (20%)
Fig. 3 is a voltage-to-current converter, with $i_{out} = gv_{in}$ where g is independent of R_L.
(a) Show that $v_a = v_b - v_{in}$ by expressing v_p in term of v_b. Then confirm that $i_{out} = gv_{in}$ and obtain the expression for g.
(b) For a specified value of $|i_{out}|_{\max}$, find the limitation on R_L needed to keep the op-amps in the linear region when they both have the supply voltages $\pm V_{PS}$.

5. (10%)
An s-domain circuit diagram yields the transfer function $H(s) = \dfrac{s^2 + 18s}{s^2 - 6s - 40}$.
Find the zero-state response $y(t)$ when the input $x(t) = 3u(t) + u(t-1)$.

6. (10%)
Let the network in Fig. 4 have $R_1 = 8\Omega, L_1 = 2H, R_2 = 4\Omega, L_2 = 1H$. Show that the input impedance is $Z(s) = (4s^2 + 16s)/(s^2 + 10s + 16)$. Then find the forced response $v(t)$ when $i_s(t) = 10\cos(4t - 90^\circ)$ A.

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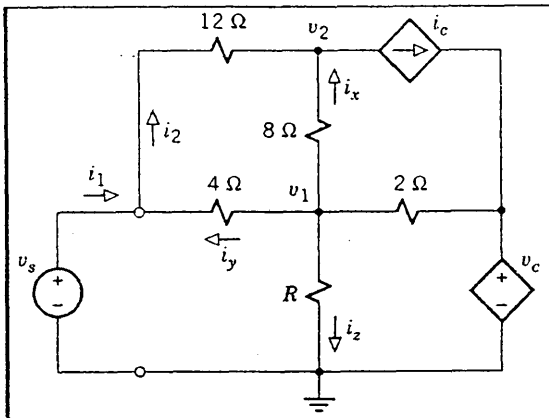


Fig. 1

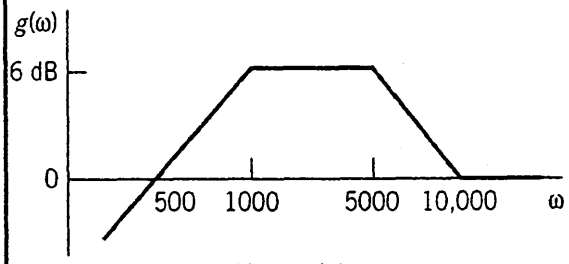
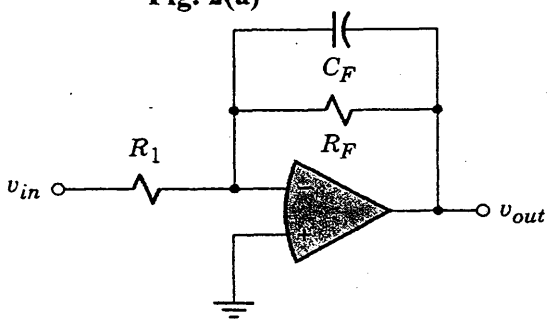
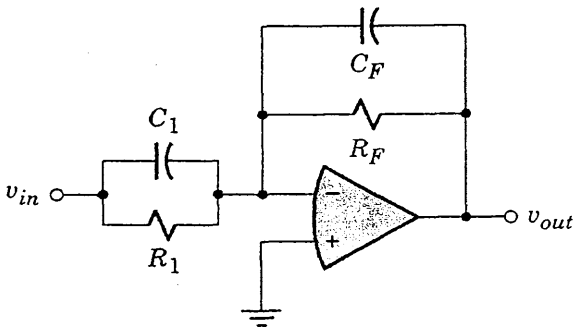


Fig. 2(a)



$$(a)\ H_a(s) = -\frac{1}{R_1 C_F}\,\frac{1}{s + 1/R_F C_F}$$



$$(c)\ H_c(s) = -\frac{C_1}{C_F}\,\frac{s + 1/R_1 C_1}{s + 1/R_F C_F}$$

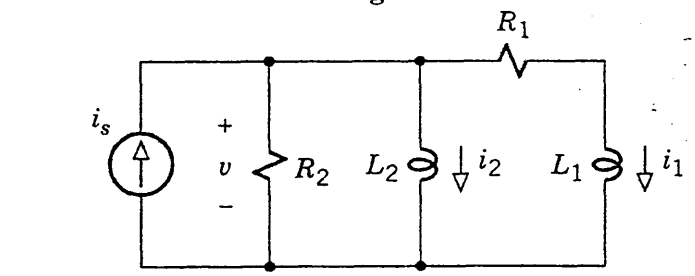
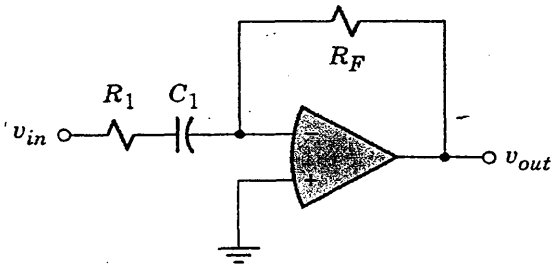
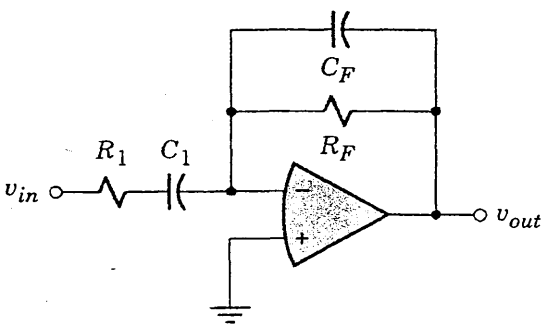


Fig. 3

Fig. 4



$$(b)\ H_b(s) = -\frac{R_F}{R_1}\,\frac{s}{s + 1/R_1 C_1}$$



$$(d)\ H_d(s) = -\frac{1}{R_1 C_F}\,\frac{s}{(s + 1/R_1 C_1)(s + 1/R_F C_F)}$$

Fig. 2(b)