科目：工程數學　　　　　系所： 電機工程學系　　　　是否使用計算機：是
考試時間：80 分鐘　　　　本科原始成績：100 分

(1) Two vectors in a rectangular coordinate system are given by $A = 2a_x + 2a_y + 3a_z$ and $B = a_x + 2a_y + 2a_z$. Determine a vector $C = ma_x - 2a_y + na_z$, which is perpendicular to both A and B and has a length of 6 　　　　　　　　　　　　　　　　(10%)

(2) Evaluate $\int_C x^2 y \, dx$, where the path of integration C is the quarter circle from (2,0) to (0,2) in Figure 1 　　　　　　　　　　　　　　　　　　　　　　　(10%)
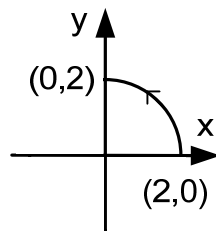

Figure 1

(3) Find a,b,c and d so that the given function is analytic 　　　　　　　　(10%)
$$f(z) = ax^2 + bxy - y^2 + i(-x^2 + cxy + dy^2)$$

(4) Find a linear mapping function f(z) that maps from S onto S' 　　　　(10%)
    S is a square with the vertices that are 0, 1, 1+i and i, from 1st to the 4th, respectively
    S' is a square with the vertices that are −2+2i, −2−2i, 2−2i and 2+2i, from 1st to the 4th, respectively

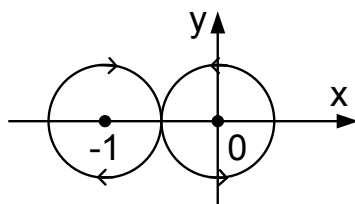(5) Evaluate $\oint_C \dfrac{3z+2}{z^2+z} \, dz$ where C is the union of two closed curves in Figure 2 　　(10%)

Figure 2

(6) Find *y(x)*, given the initial value problem $y'' - 4y = 12x$，$y(0) = 4$，$y'(0) = 1$　　　(10%)

(7) Find *y(x)*, given the initial value problem $y'' + 2y' + 5y = \delta(t - 2\pi)$，$y'(0) = 0, y(0) = 0$

(10%)

(8) Solve $X' = \begin{pmatrix} 0 & 2 \\ -1 & 3 \end{pmatrix} X + \begin{pmatrix} 2t \\ 1 \end{pmatrix}$　　　(10%)

(9) Find the Fourier series of　*f (x)*

(10%)

$$f(x) = \begin{cases} 0, & -2 < x < -1 \\ -1, & -1 \le x < 0 \\ 1, & 0 \le x < 1 \\ 0, & 1 \le x < 2 \end{cases}$$

(10) If an 3×3 matrix product AB=C, where $A = \begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{bmatrix}, C = \begin{bmatrix} 1 & -1 & 1 \\ 2 & 1 & 0 \\ 0 & -1 & -2 \end{bmatrix}$, determine matrix B

(10%)

科目：電路學　　　　　系所：電機工程學系
考試時間：80 分鐘　　　本科原始成績：100 分　　　是否使用計算機：是

1. (10%) Consider the two-terminal element with the *v-i* characteristic expressed by the function as

$$i(v) = 3v^2 + 2v + 1$$

where i is the current in ampere and v is the terminal voltage in volt.

(a) (5%) Find the static resistance at $v = 2$ V.

(b) (5%) Find the dynamic resistance at $v = 2$ V.

2. (15%) Consider the bridge network shown in Fig. P2.

(a) (10%) Determine the equivalent resistance R_{ab} at terminals *a-b*.
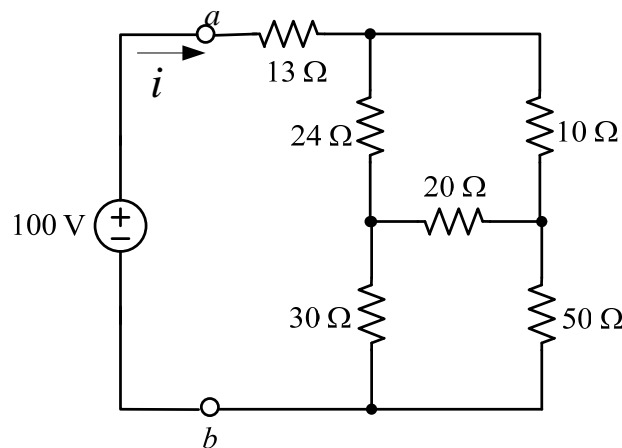
(b) (5%) Find *i*.

Fig. P2

3. (15%) Consider the circuit shown in Fig. P3.

(a) (9%) Write a set of node-voltage equations.

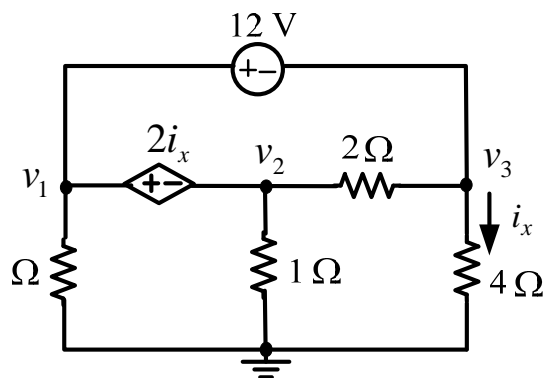(b) (6%) Determine the node voltages v_1, v_2, and v_3.

Fig. P3

科目：電路學　　　　　系所：電機工程學系　　　　是否使用計算機：是
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4. (15%) Sketch the straight-line approximation of the Bode plot for the following transfer function.

$$H(s) = \frac{10^{10} s}{(s + 10^3)(s + 10^5)}$$

5. (15%) Consider the parallel *RLC* circuit in Fig. P5. Assume that $v(0) = 5$ V, $i(0) = 0$ A, $L = 1$ H, $C = 10$ mF, and $R = 5\,\Omega$. Find $v(t)$ for $t \geq 0$.
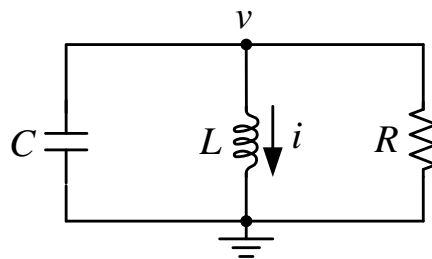

Fig. P5

6. (15%) Use *source transformation* to find the current I_o in Fig. P6.
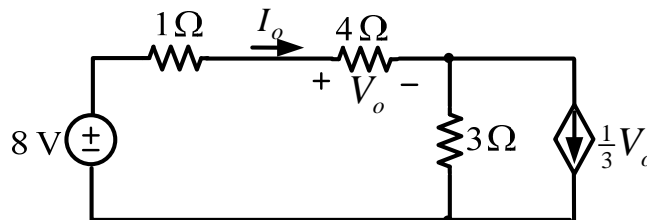

Fig. P6

7. (15%) The constants *R* and *L* of a coil can be obtained by connecting the coil in series with a known resistance and measuring the coil voltage V_x, the resistor voltage V_1, and the total voltage V_T (Fig. P7). The frequency must also be known, but the phase angles of the voltages are not known. Given that $\omega = 100\,\text{rad/s}$, $V_1 = 10$ V, $V_x = 20\sqrt{5}$ V, and $V_T = 50$ V, find *R* and *L*.
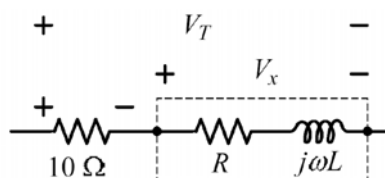

Fig. P7