1. Use the ideal op-amp model to determine the functional relationship between voltage $v$ and current $i$, $v = f(i)$ for the network shown in Fig. 1, if the functional relationship between $v_L$ and $i_L$ is

$$v_L = g(i_L)$$

or

$$i_L = g^{-1}(v_L)$$

What is the equivalent circuit connected between terminal $a$ and $b$ in the circuit if the load is an inductance of the value $L$? (15 %)

![Fig. 1](image_url)

2. Determine $i_o$ for the network shown in Fig. 2. (10 %)

![Fig. 2](image_url)
3. In the network in Fig. 3, switch 1 has been open for a very long time, switch 2 has been closed for a very long time, and switch 1 is closed at $t = 0$. Find:
(a) $v_1(0^+), i_1(0^+), v_2(0^+), i_2(0^+)$. (5 %)
(b) $v_1(0^+), i_1(0^+), v_2(0^+), i_2(0^+)$. (5 %)
(c) $v_1(\infty), i_1(\infty), v_2(\infty), i_2(\infty)$. (5 %)
(d) The complete response for $v_1(t)$ when $t > 0$. (10 %)

![Fig. 3](image)

4. Construct a Bode plot for a high-pass RL filter with inductor voltage as the output. (15%)

5. For the simplified transformer model with all impedance referred to the primary side and the complex turns ratio of $a : 1$, find the current ratio and the node admittance matrix $Y$ where
\[ \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} \] (15%)

![Diagram](image)

6. Two balanced three-phase loads are connected to a 440-V three-phase line. One load draws 60 kW at a power factor of 0.6 lagging and the other draws 75 kVA at a power factor of 0.8 leading. What line current is required to supply the combined load? (20%)