Problem 1. (15%)

Consider the Zener-diode regulator circuit shown in Figure 1-1. The diode characteristic is shown in Figure 1-2. Let V_{SS}=24V, R=1.2kΩ, and R_L=6kΩ.

(a) (10%) Find the load voltage v_L.
(b) (5%) Find the source current I_S.

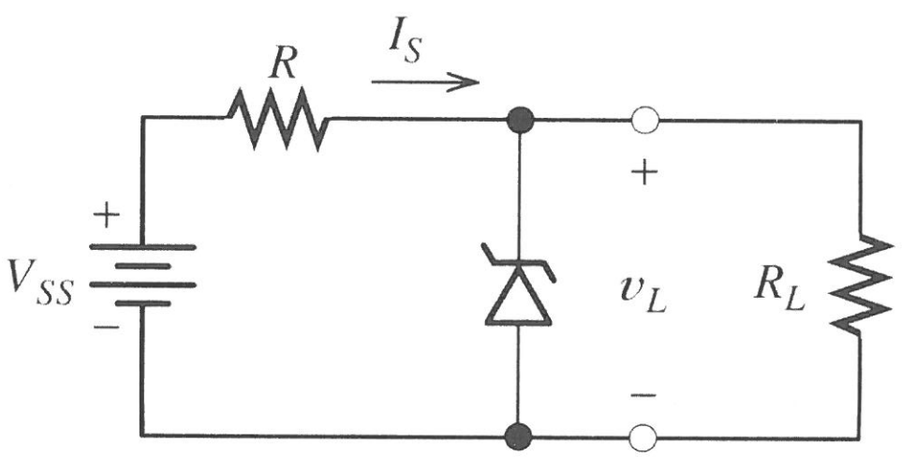


Fig. 1-1

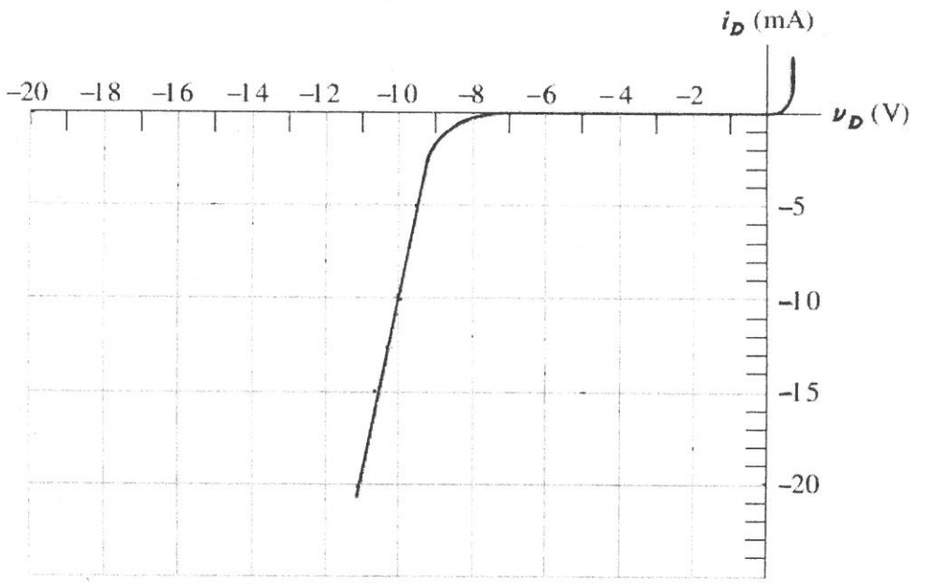
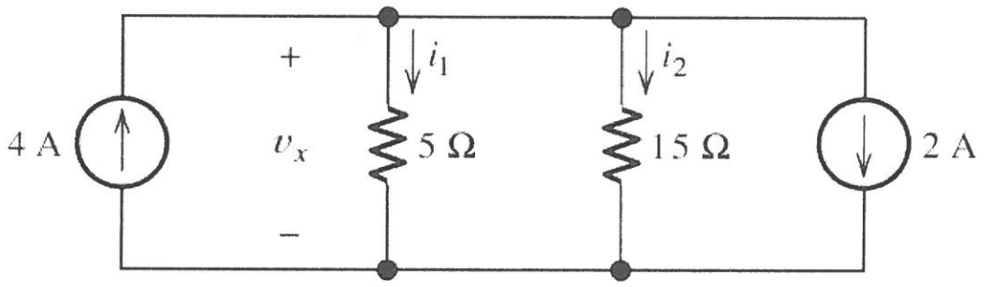


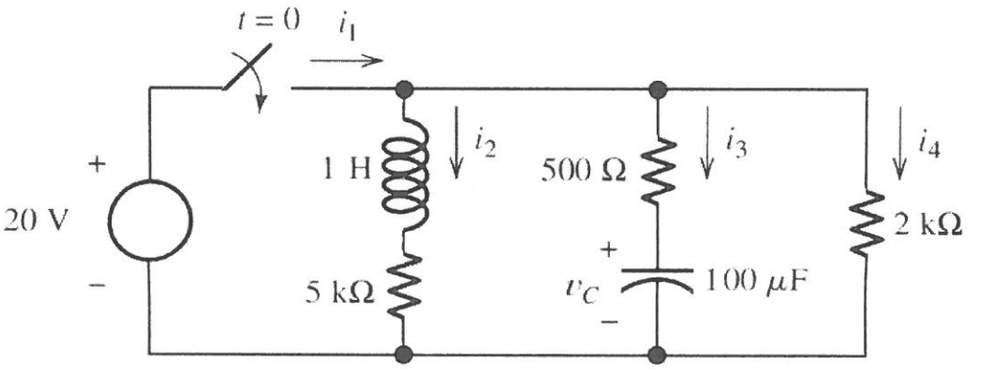
Fig. 1-2

Problem 2. (20%)

(a) (10%) Find the values of i_1 and i_2 for the circuit shown below.



(b) (10%) Solve for the steady-state values of i_1,i_2,i_3,i_4, and v_c for the circuit shown below after the switch has been closed for a long time.

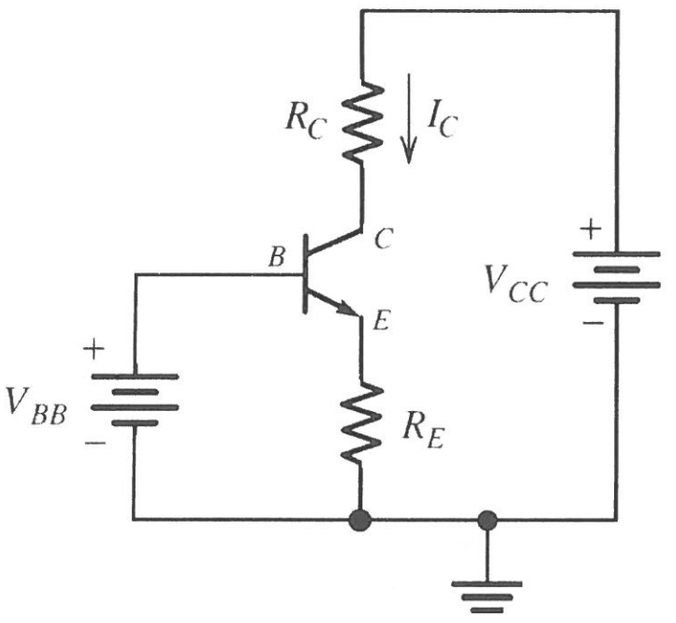


Problem 3. (15%)

For the circuit shown below, let $V_{CC} = 15\text{V}$, $V_{BB} = 5\text{V}$, $R_C = 2\ \text{k}\Omega$, $R_E = 2\ \text{k}\Omega$, and $\beta = 100$.

(a) (10%) Solve for I_C

(b) (5%) Solve for V_{CE}



Problem 4. (30%)

Operational amplifier can be used to synthesize many useful circuits. Please answer the following questions regarding operational amplifier.

(a) (10%) Draw an adder circuit using ideal operational amplifier and resistors. Please verify your result, i.e., show that the circuit possesses the function of adding.

(b) (10%) Draw a differentiator circuit using ideal operational amplifier, resistors, and capacitor. Please verify your result, i.e., show that the circuit possesses the function of differentiation.

(c) (10%) Draw an integrator circuit using ideal operational amplifier, resistors, and capacitor. Please verify your result, i.e., show that the circuit possesses the function of integration.

Problem 5. (20%)

Consider the circuit shown below, where the voltage source is $v_s(t) = 10\cos 3t$ (Volt), and the electronic components are given by $R_1 = 1\Omega$, $R_2 = 2\Omega$, $C = 1F$, $L = 2H$. Please derive the governing circuit equation (ordinary differential equation) in terms of the capacitor voltage v_c.