

**Problem 1. (15%)**

Consider the Zener-diode regulator circuit shown in Figure 1-1. The diode characteristic is

shown in Figure 1-2. Let  $V_{SS} = 24\text{V}$ ,  $R = 1.2\text{k}\Omega$ , and  $R_L = 6\text{k}\Omega$ .

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

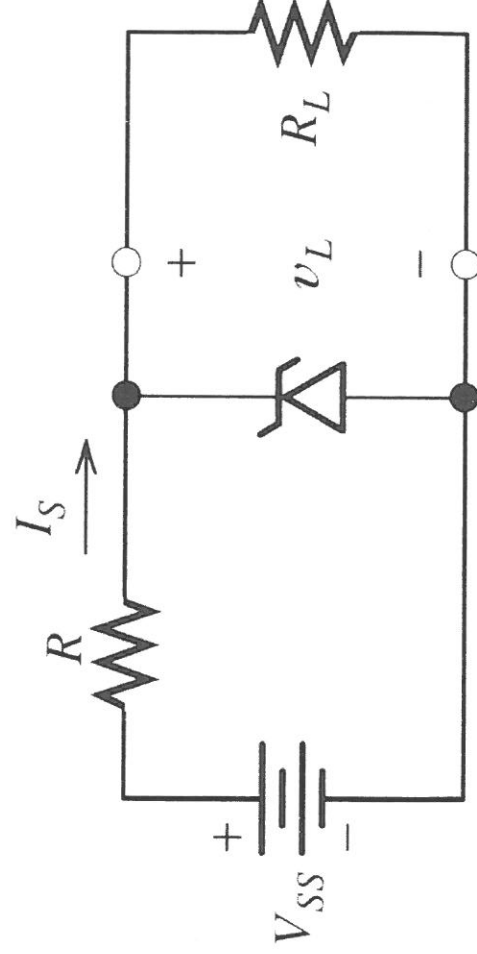


Fig. 1-1

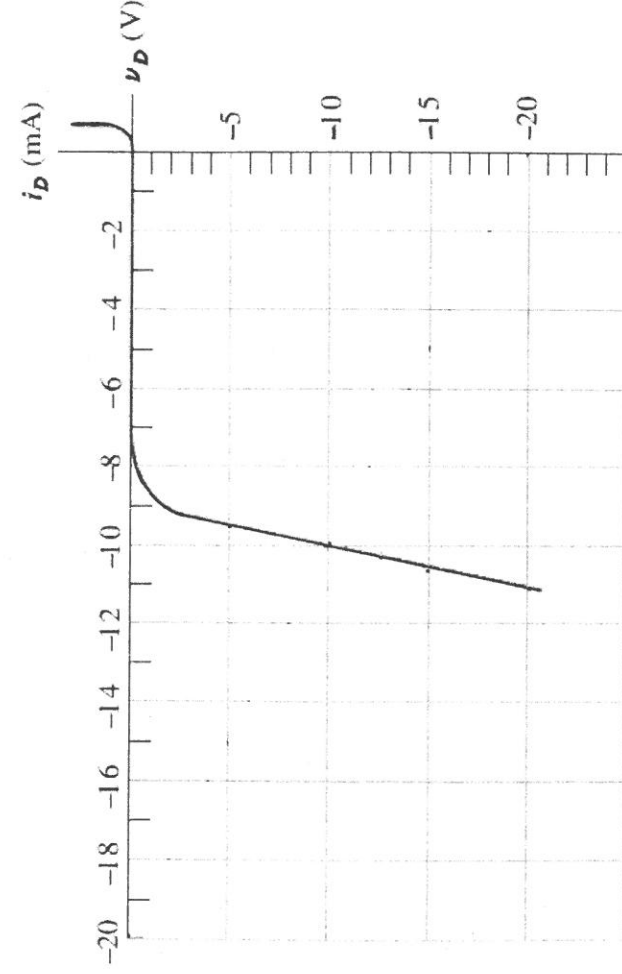
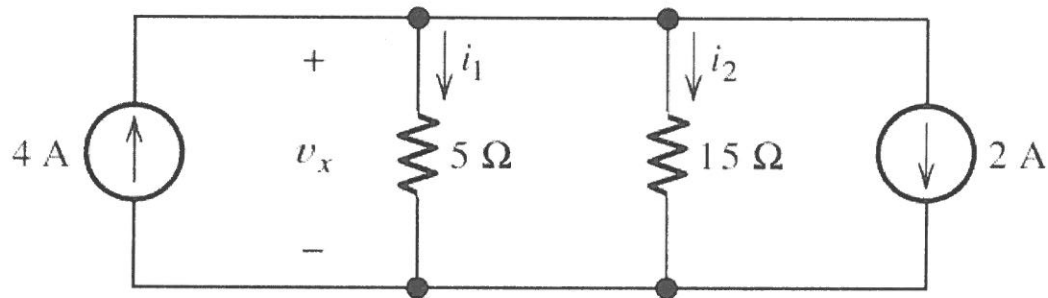


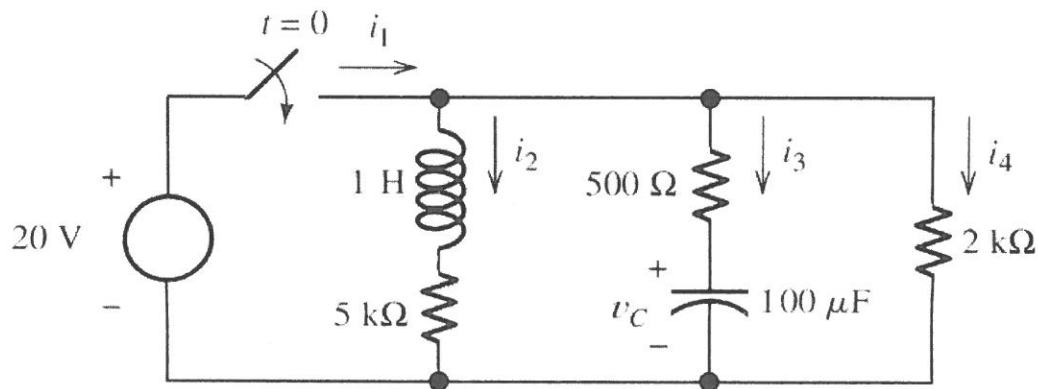
Fig. 1-2

**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.

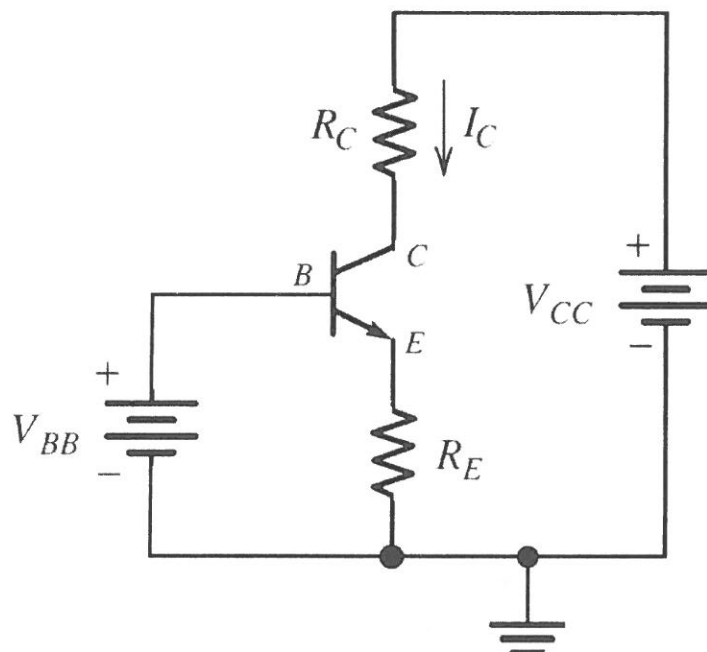


**Problem 3. (15%)**

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

