電子學一　HW2

1. Problem 2.64 on Sedra & Smith 8th ed.

Using the difference amplifier configuration of Fig. 2.16 and assuming an ideal op amp, design the circuit to provide the following differential gains. In each case, the differential input resistance should be 10 kΩ.

(a) 1 V/V (b) 5 V/V (c) 10 V/V (d) 25 V/V

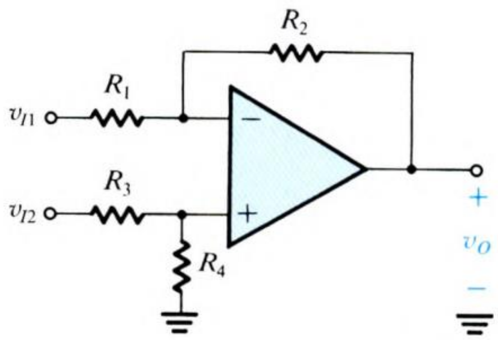


Figure 2.16

2. Problem 2.65 on Sedra & Smith 8th ed.

For the circuit shown in Fig. P2.65, express v_O as a function of v_1 and v_2. What is the input resistance seen by v_1 alone? By v_2 alone? By a source connected between the two input terminals? By a source connected to both input terminals simultaneously?

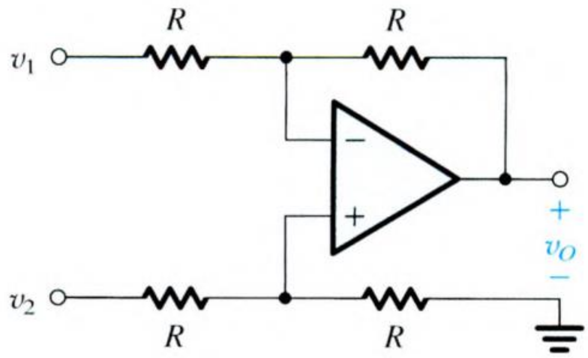


Figure P2.65

3. Problem 2.69 on Sedra & Smith 8th ed.

To obtain a high-gain, high-input-resistance difference amplifier, the circuit in Fig. P2.69 employs positive feedback, in addition to the negative feedback provided by the resistor R connected from the output to the negative input of the op amp. Specifically, a voltage divider (R_5, R_6) connected across the output feeds a fraction β of the output, that is, a voltage βv_O, back to the positive-input terminal of the op amp through a resistor R. Assume that R_5 and R_6, are much smaller than R so that the current through R is much lower than the current in the voltage divider, with the result that $\beta \cong R_6/(R_5 + R_6)$. Show that the differential gain is given by

$$A_d \equiv \frac{v_O}{v_{Id}} = \frac{1}{1-\beta}$$

(Hint: Use superposition.)

Design the circuit to obtain a differential gain of 10 V/V and differential input resistance of 2 MΩ. Select values for R, R_5, and R_6, such that $(R_5 + R_6) \leq R/100$.

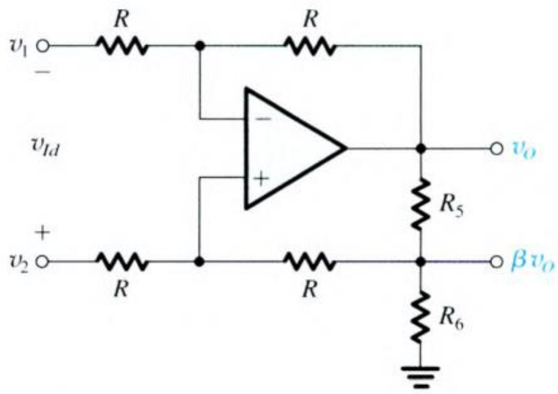
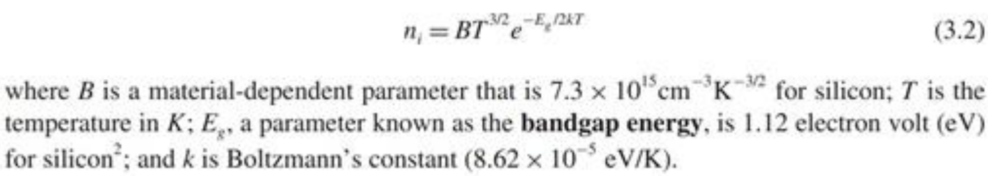


Figure P2.69

4. For a p-type silicon in which the dopant concentration $N_A = 5 \times 10^{18}/\text{cm}^3$, find the hole and electron concentrations at T=300K . (Use the parameter given below)



$$n_i = BT^{3/2}e^{-E_g/2kT} \quad (3.2)$$

where B is a material-dependent parameter that is $7.3 \times 10^{15}\text{cm}^{-3}\text{K}^{-3/2}$ for silicon; T is the temperature in K; E_g, a parameter known as the **bandgap energy**, is 1.12 electron volt (eV) for silicon[2]; and k is Boltzmann's constant (8.62×10^{-5} eV/K).

5. Assuming that the temperature dependence of I_s arises mostly because I_s proportional to n_i^2, use the expression for n_i in Eq3.2 (given in problem 4.) to determine the factor by which n_i^2 changes as T changes from 300K to 305K. This will be approximately the same factor by which I_s changes for a 5°C rise in temperature. What is the factor?

6. Calculate I_s and the current I for V = 750mV for a pn junction for which $N_A = 10^{17}/\mathrm{cm}^3$, $N_D = 10^{16}/\mathrm{cm}^3$, A = 100μm^2, $n_i = 1.5 \times 10^{10}/\mathrm{cm}^3$, L_p = 5μm, L_p = 10μm, $D_p = 10\mathrm{cm}^2/s$, and $D_n = 18\mathrm{cm}^2/s$.

5. Assuming that the temperature dependence of I_s arises mostly because I_s proportional to n_i^2, use the expression for n_i in Eq3.2 (given in problem 4.) to determine the factor by which n_i^2 changes as T changes from 300K to 305K. This will be approximately the same factor by which I_s changes for a 5°C rise in temperature. What is the factor?

6. Calculate I_s and the current I for V = 750mV for a pn junction for which N_A = $10^{17}/\mathrm{cm}^3$, N_D =$10^{16}/\mathrm{cm}^3$, A = 100$\mu\mathrm{m}^2$, n_i = $1.5 \times 10^{10}/\mathrm{cm}^3$, L_p= 5μm , L_p= 10μm , D_p =$10\mathrm{cm}^2/s$, and D_n =$18\mathrm{cm}^2/s$.