模电知识点汇总

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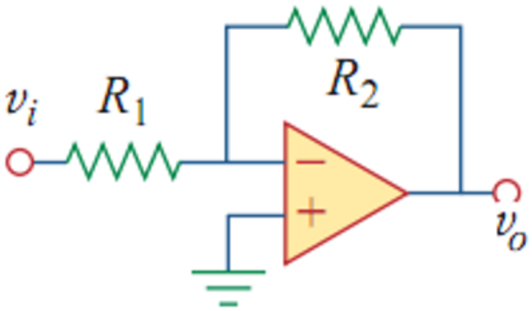
At the beginning, the theories of all kinds of elements are unnecessary, you just need to know how to solve out the problems, that's the point.

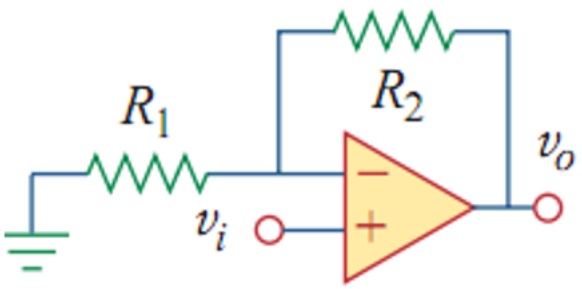
1 Operator Amplifier

5 basic Op-Amp models：



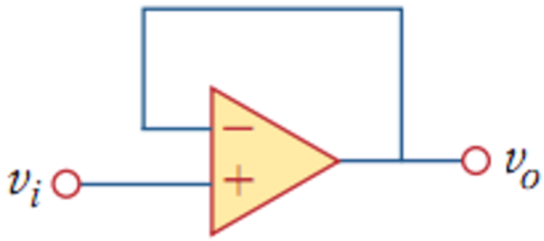
$$v_o = -\frac{R_2}{R_1}v_i$$

Figure 1: Inverting Amplifier



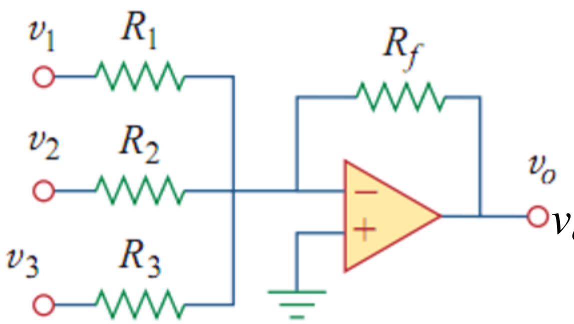
$$v_o = (1 + \frac{R_2}{R_1})v_i$$

Figure 2: Inverting Amplifier



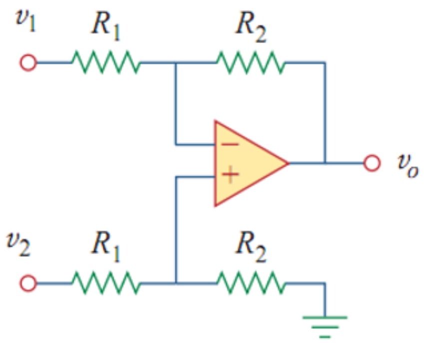
$$v_o = v_i$$

Figure 3: Inverting Amplifier



$$v_o = -(\frac{R_f}{R_1}v_1 + \frac{R_f}{R_2}v_2 + \frac{R_f}{R_3}v_3)$$

Figure 4: Inverting Amplifier



$$v_o = \frac{R_2}{R_1}(v_2 - v_1)$$

Figure 5: Inverting Amplifier

2 Basic Diode

The theory of diodes is PN junction, OK, that's not matter. The most import is the 4 models of Diode: ideal model, case 1 model, case 2 model, small signal model.

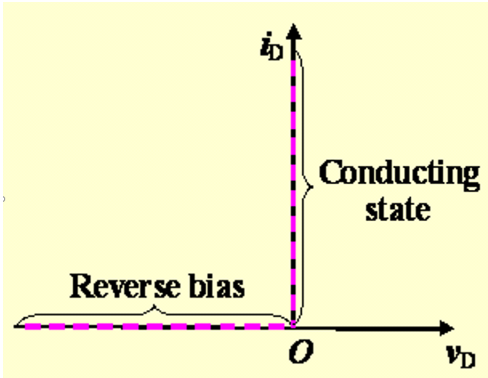
We first introduce the $i_D - v_D$ relationship:

$$i_D = I_S(e^{\frac{v_D}{nV_T}} - 1)$$

In this equation: n-ideality factor(for ideal diode, $n = 1$), I_S-reverse-bias saturation current, V_T-thermal voltage at room temperature(In general, $V_T = 0.026\text{V}$). And at the turning point, we define: V_γ-turn-on or cut-in voltage.

Now we introduce the 4 diode model:

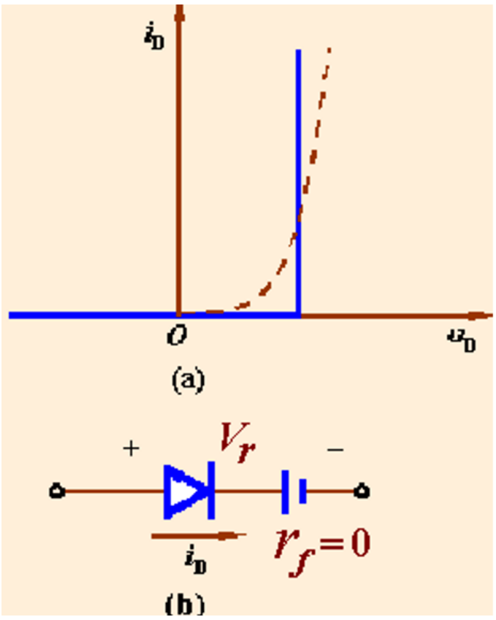
Ideal model: the conduction voltage drop equals $0(V_\gamma = 0)$, and When reverse bias, the resistor is ∞



$$V_\gamma = 0, r_d = \infty$$

Figure 6: Inverting Amplifier

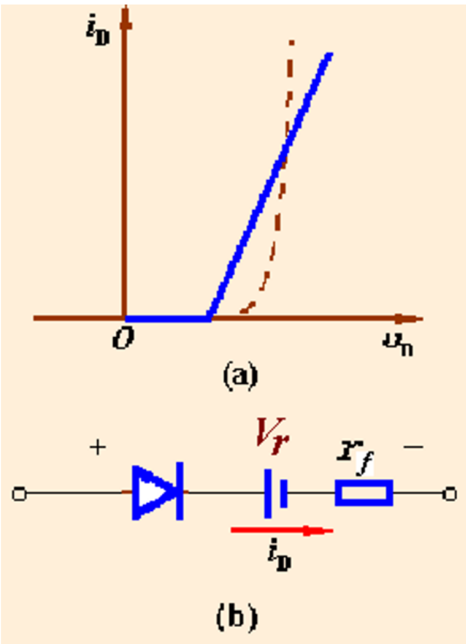
Case 1 model: consider conduction voltage drop($V_\gamma = 0.6\ 0.7$V), when reverse bias, it's the same as the ideal model



$$V_\gamma = 0.6\,0.7\text{V}, r_d = \infty$$

Figure 7: Inverting Amplifier

Case 2 model: consider conduction voltage drop Forward diode resistance, when reverse bias, it's the same as the ideal model.



$$V_\gamma = 0.6\ 0.7\text{V}, r_d \neq \infty$$

Figure 8: Inverting Amplifier

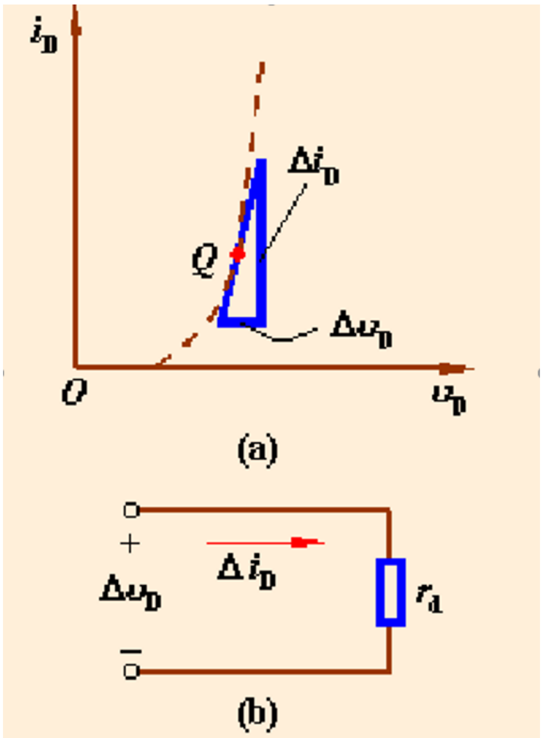
Small signal model: it's a model use for AC analysis. When a diode is operating in the small range， it can be a small-signal incremental resistance:

$$r_d = \frac{\Delta v_D}{\Delta i_D}$$

We have equation:$i_D = I_S(e^{\frac{v_D}{V_T}} - 1)$, therefore:

$$g_d = \left.\frac{\mathrm{d}i_D}{\mathrm{d}v_D}\right|_Q = \left.\frac{I_S e^{\frac{v_D}{V_T}}}{V_T}\right|_Q = \left.\frac{I_{DQ}}{V_T}\right|_Q (e^{\frac{v_D}{V_T}} \approx e^{\frac{v_D}{V_T}} - 1)$$

$$\Rightarrow r_d = \left.\frac{V_T}{I_{DQ}}\right|_Q$$



$$V_\gamma = 0.6 - 0.7\text{V}, r_d = \left.\frac{V_T}{I_{DQ}}\right|_Q$$

Figure 9: Inverting Amplifier

3 Other Diodes

To analyze diode, The most important thing is to discuss all cases of diode, and you may need to consider conductivity of different diodes.

Half-Wave Rectifier Just Diode

Full-Wave Rectifier:

1.Rectifier with center-tapped transformer

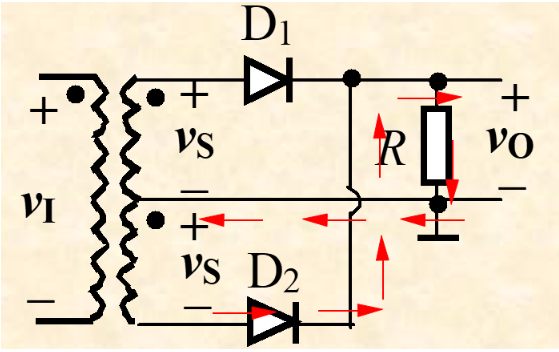


Figure 10: Inverting Amplifier

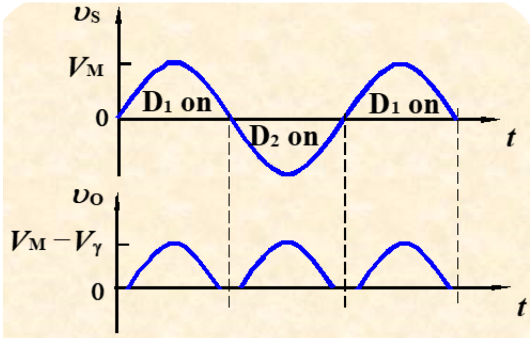


Figure 11: Inverting Amplifier

2.Bridge eectifier

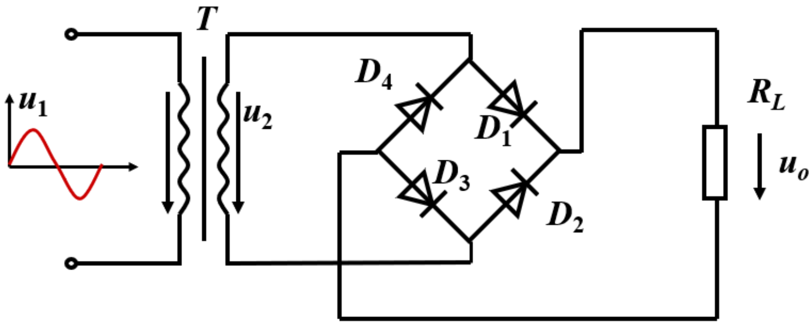


Figure 12: Inverting Amplifier

Zener Diode:

4 MOSFET

5 BJT

6 Frequency Response

7 Power-Amplifier

For simple Amplifiers, there is too much power loss occurring in the amplifiers, so the efficiency is too low. Therefore, we try to change the Q-point. OK, Let's skip the small talk and get straight to the point.

First of all, one of the most important things is that the small-signal model is no longer applicable in the case, because the v_i is big signal whose magnitude can be comparable to V_{CC}.

Now we introduce 3 classes of Power Amplifiers:

Class A:

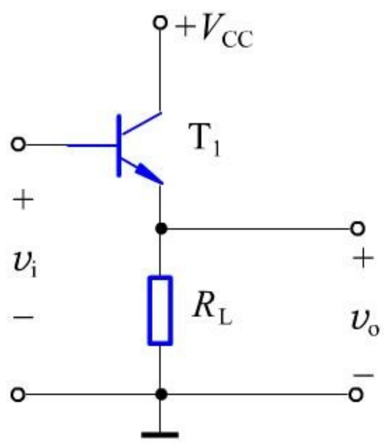


Figure 13: Class A NPN-BJT

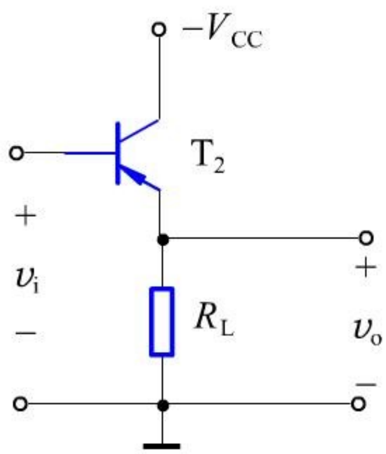


Figure 14: Class A PNP-BJT