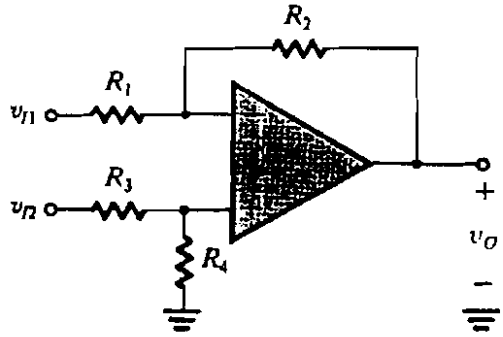
1. Give a circuit shown as follow, where v_o is the output voltage and v_1 and v_2 are input voltage. [20]



Please answer the following questions:

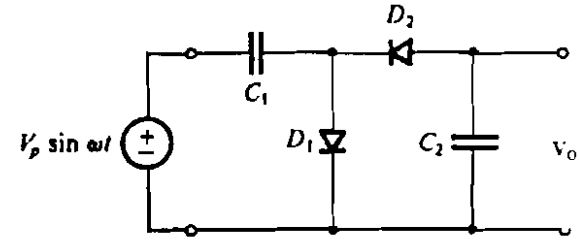
a、 What is the input resistance seen by v_1 alone? (by setting to v_2 to zero)

b、 What is the input resistance seen by v_2 alone? (by setting to v_1 to zero)

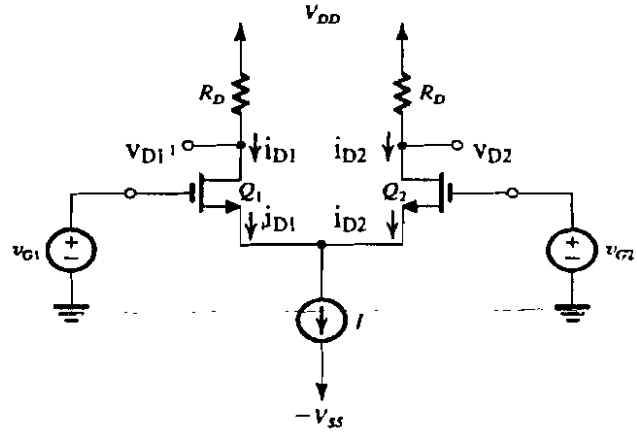
c、 Give the output voltage v_o with respect to the resistors R_1, R_2, R_3, R_4 and input v_1 and v_2.

d、 If the output is proportional to the voltage difference (v_1 - v_2), then this circuit is called as OP difference amplifier. Please give the relationships between R_1, R_2, R_3 and R_4 which can make this circuit.

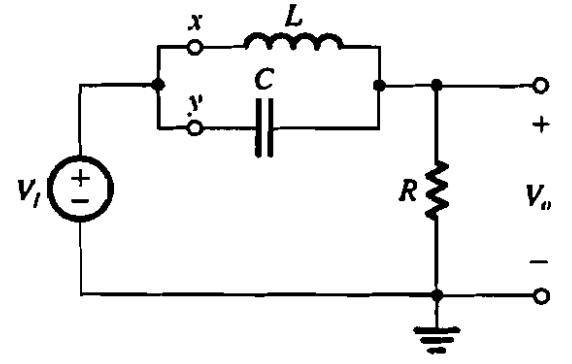
2. Give a circuit, shown as follow, composed of two sections in cascade: a clamp formed by C_1 and D_1, and a peak rectifier formed by D_2 and C_2. When the circuit is excited by a sinusoid of amplitude V_p, the clamping section provides the voltage waveform of output v_o. Please the output voltage v_0 and draw it. Note that this circuit is commonly called by voltage doubler. [15]



3. Give a basic MOS differential-pair circuit, shown as follow. It consists two matched transistors Q_1 and Q_2, whose sources and joined together and biased by a constant-current source I. Please derive the voltage of v_{D1} and v_{D2}. [15]



4. Give a "Notch" filter, shown as follow. The natural frequency is $w_0 = \sqrt{LC}$. [15]



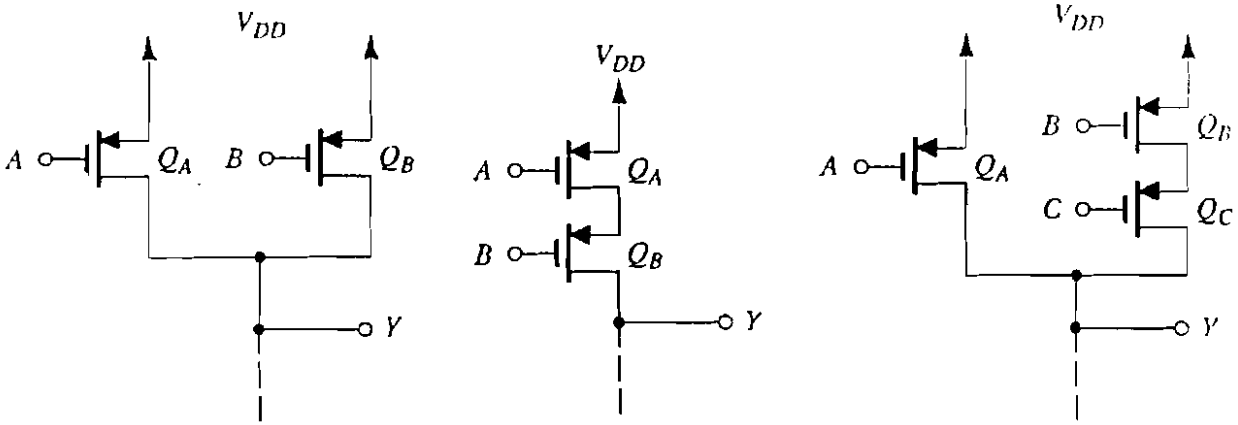
a、 Please show the transfer function.

$$G(s) = \frac{V_o(s)}{V_i(s)} = \frac{a(s^2 + w_0^2)}{s^2 + s(w_0/Q) + w_0^2}$$

b、 Please give the value of a.

c、 Please show the value of Q.

5. Give three pull-down CMOS gates circuits, please try to analyze those circuits and give their Boolean expression with respect to inputs and output. [15]



(a) (b) (c)

6. The α is called as common-base current gain. And the β as common-emitter current gain. Please answer the following questions: [20]

a、 The relationship between i_E, i_C and i_B.

b、 The relationship between i_E and i_C with respect to α.

c、 The relationship between i_E and i_C with respect to β.

d、 The relationship between α and β.