請按題目順序作答

1. Consider the class-B output stage shown in Fig. 1. The transistor parameters are $|V_{th}| = 0$ and $k_n' = k_p' = 0.4\,\text{mA/V}^2$. Let $R_L = 5\,\text{k}\Omega$.

(a) Find the maximum output voltage such that Q_N remains biased in the saturation region. What are the corresponding values of i_L and v_I for this condition? (8 分)

(b) Determine the conversion efficiency for a symmetrical sine-wave output signal with the peak value found in part (a). (8 分)

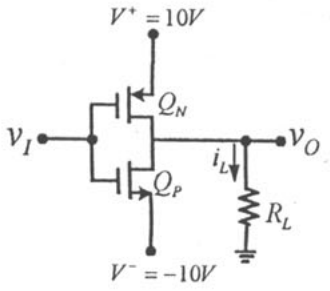

Fig. 1

2. Consider the current-to-voltage converter circuit shown in Fig. 2. The input resistance R_{if} is assumed to be small, the output resistance is $R_o = 0$, and the op-amp gain A is large. The closed-loop transfer function can be written in the form

$$A_f = \frac{v_o}{i_s} = \frac{A}{1 + A\beta}$$

(a) What is the expression for β. (8 分)

(b) If $A = 5\times10^6\ \Omega$ and $A_f = 5\times10^4\ \Omega$, what is the required R. (8 分)

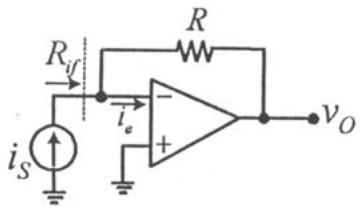

Fig. 2

3. Find the frequency of oscillation and the R_2/R_1 required for oscillation for the circuit shown in Fig. 3. (16 分)

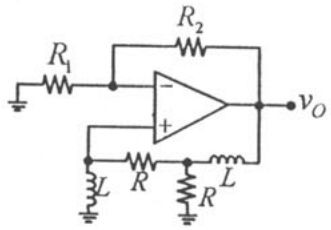

Fig. 3

4. For the circuit in Fig. 4(a), utilizing ideal diodes, determine and sketch the output $v_O(t)$ for the input $v_I(t)$ shown in Fig. 4(b). Assume $CR = T$. (16 分)

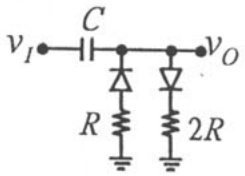

Fig. 4(a)

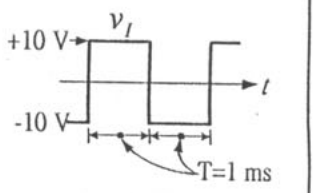

Fig. 4(b)

5. An amplifier is formed by cascading n identical amplifier stages, each having a high-pass single-time-constant frequency response with a 3-dB frequency f_1 and a low-pass single-time-constant frequency response with a 3-dB frequency f_2. Find the lower 3-dB frequency and upper 3-dB frequency of the overall amplifier in terms of f_1, f_2 and n. (18 分)

6. (a) Sketch a CMOS realization for the function $Y = \overline{A + B(C + DE)}$. (b) Sketch a CMOS logic circuit that realizes the function $Y = ABC + \overline{A}\,\overline{B}\,\overline{C}$. (18 分)