1. The closed-loop circuit in Fig. 1 can be used as an oscillator.
   (a) Please derive the condition to satisfy the Barkhausen criterion. What is the oscillation frequency? [10%]
   (b) Given that $R = 10\ k\Omega$, how do you choose R_F and C to have an oscillation frequency of $100\ kHz$? [10%]

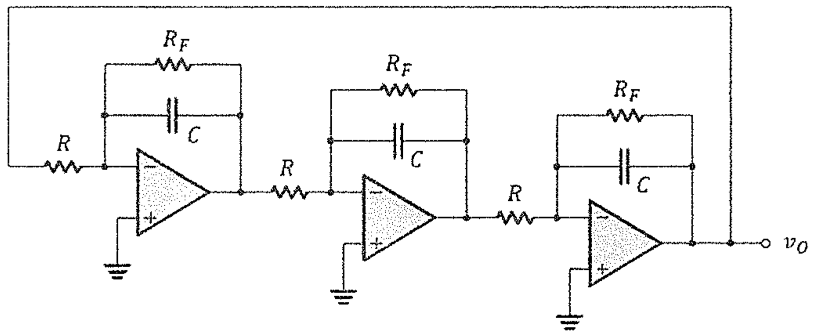

Fig. 1

2. For a MOSFET, the parameters are given as $\mu_n C_{ox}(W/L) = 8\ mA/V^2$, $V_t = 1\ V$ and $V_A = 20\ V$. If the MOSFET is operated in saturation with a dc current of I, the transconductance is identical to that of a BJT operating in active mode with a dc current of $0.1I$.
   (a) Find the value of I. [5%]
   (b) What is the small-signal output resistance (r_o) of the MOSFET? [5%]
   (c) Find the intrinsic gain of the MOSFET. [5%]
   (d) If the BJT has the same value of V_A, find the intrinsic gain of the BJT operating at a dc current of $0.1I$. [5%]
3. At higher frequencies, the MOSFET is characterized by its small-signal model by including C_{gs} and C_{gd}.
   (a) The high-frequency current gain of the MOSFET is typically evaluated by the circuit in Fig. 3. Derive the transfer function of the current gain $T(s) \equiv I_o/I_s$. [5%]
   (b) Based on $T(s)$, find the unity-gain frequency ω_t by assuming C_{gd} is relatively small. [5%]
   (c) For fixed DC voltage V_{GS}, how does ω_t change as channel width doubles? Why? [5%]
   (d) For fixed DC voltage V_{GS}, how does ω_t change as channel length doubles? Why? [5%]

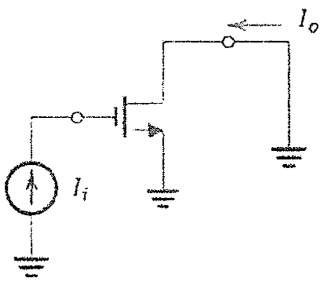

Fig. 3

見背面

4. For the circuit in Fig. 4, assume the op-amp is ideal and the resistors are given as $R = 5\ k\Omega$, $R_1 = 10\ k\Omega$, and $R_2 = 20\ k\Omega$.
   (a) Given $I_S = 1 \times 10^{-15}\ A$ for the diodes, find the output voltage when $v_I = 1\ V$. [5%]
   (b) If the diodes are ideal, plot the voltage transfer curve (plot of v_O versus v_I). Find the output voltage when $v_I = 1\ V$. [10%]

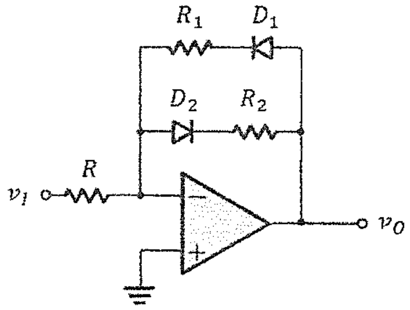

Fig. 4

5. Assume C_1 and C_2 are ideal coupling capacitors for the circuits in Fig. 5.
   (a) For the circuit in Fig. 5(a), find the input resistance (R_{in}), output resistance (R_o) and open-circuit voltage gain (A_{vo}) of the amplifier. [15%]
   (b) For the circuit in Fig. 5(b), find the bias current I needed to obtain a voltage gain (v_o/v_s) of 15. [10%]

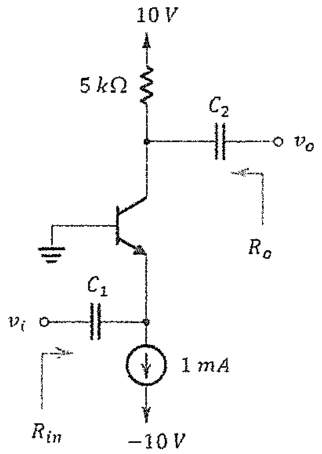

Fig. 5(a)

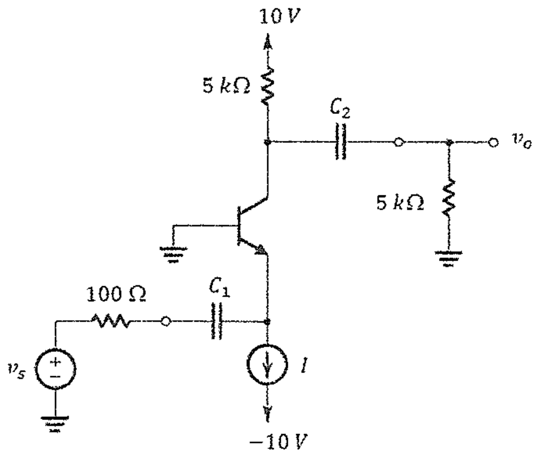

Fig. 5(b)

試題隨卷繳回