國立中央大學98學年度碩士班考試入學試題卷

所別：光電科學與工程學系碩士班 一般生　科目：電子學　共 4 頁 第 1 頁

＊請在試卷答案卷（卡）內作答

1. At room temperature $V_T = 0.026$ V, consider the circuit shown in Fig. 1.
   (a) (5%) Determine the diode current I_D and diode voltage V_D for $V_\gamma = 0.6$ V.
   (b) (5%) Define a load line of this circuit.
   (c) (5%) Determine the diode small-signal incremental resistance r_d.

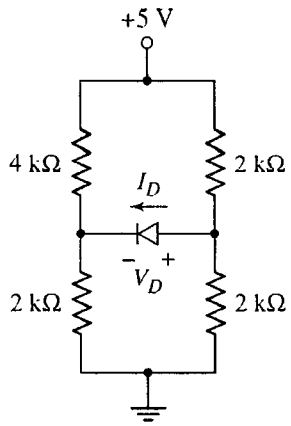

Fig. 1

2. At room temperature $V_T = 0.026$ V, consider the circuit shown in Fig. 2. The parameters are $\beta = 150$, $V_{BE}(\text{on}) = 0.7$ V, $V_A = \infty$, $C_\pi = 10$ pF, and $C_\mu = 1$ pF.
   (a) (5%) Find the working point of transistor.
   (b) (5%) Find the input resistance R_i.
   (c) (5%) Determine the upper 3 dB frequencies corresponding to the input and output portions of the equivalent circuit.
   (d) (5%) Calculate the small-signal midband voltage gain.

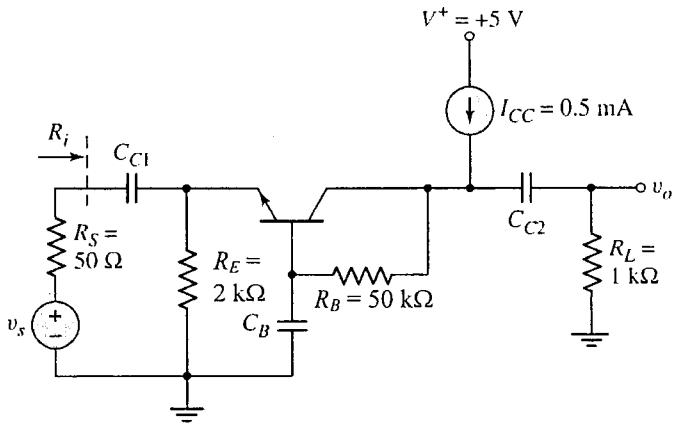

Fig. 2

參考用

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3. The transistor in the circuit in Fig. 3 has parameters V_{TN} = 0.8 V and Kn = 0.25 mA/V^2; V_{DD} = 3 V and R_D = 0.5 kΩ.
   (a) (5%) Sketch the load line and plot the Q-point (working point). Please judge what is the operating bias region for each condition?
   (b) (5%) Determine the small-signal voltage gain Av.
   (c) (5%) Please explain the reason whether the transistor in the circuit could be used as an amplifier or not.

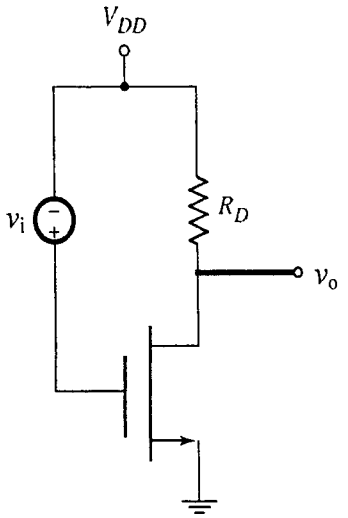
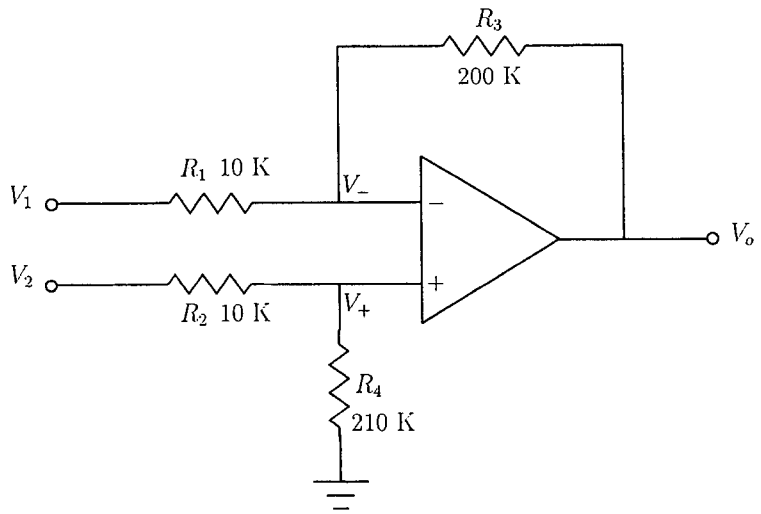


Fig. 3

4. The OP amp shown below is ideal. Determine the numerical values for the questions below.



(a) (4%) V_o = _____ V_2 + _____ V_1

(b) (2%) Find the input resistance seen by an input signal source applied at V_1 when V_2 is grounded, $R_{in,1}$ = _____ .

(c) (4%) Find the common mode input resistance for this amplifier, $R_{in,CM}$ = _____ .

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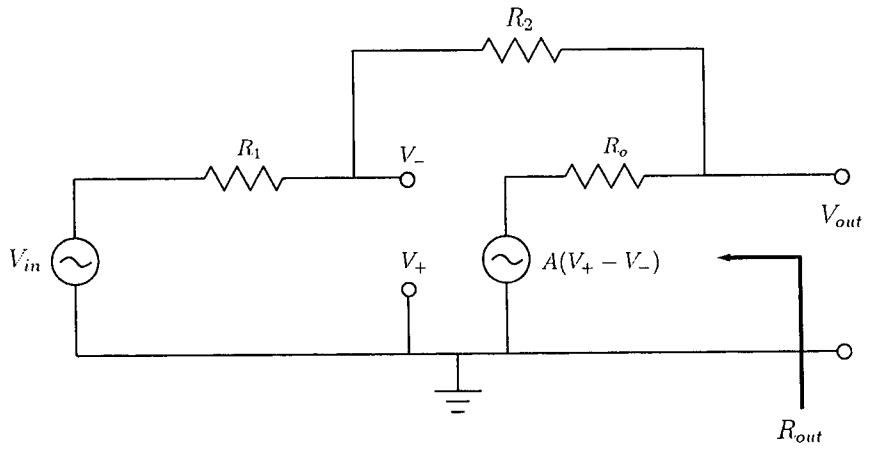
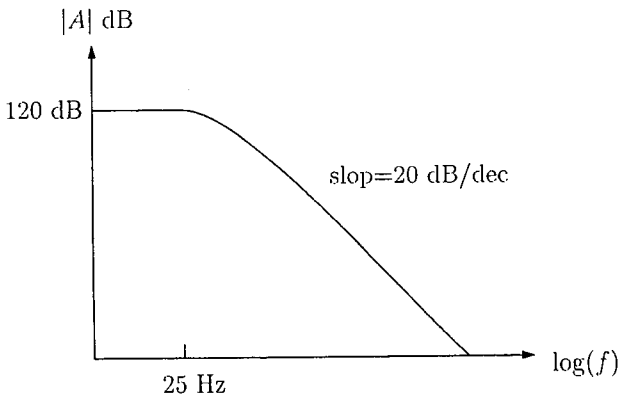
5. Consider the following amplifier equivalent circuit using a non-ideal OP amp. The OP amp has a finite output resistance R_o and a finite open-loop gain A. The inverting and non-inverting terminals of the OP amp are the V_- and V_+ nodes respectively, and the output terminal is the V_{out} node. All node voltages are referenced to ground.



(a) (5%) Find the closed-loop gain $A_v = V_{out}/V_{in}$ in terms of R_1, R_2, R_o, and A.
(b) (5%) Find the output impedance R_{out} in terms of R_1, R_2, R_o, and A.
(c) (5%) The amplitude response of the open-loop gain is shown below. Compute the closed-loop voltage gain and output impedance at $f = 1$ MHz.



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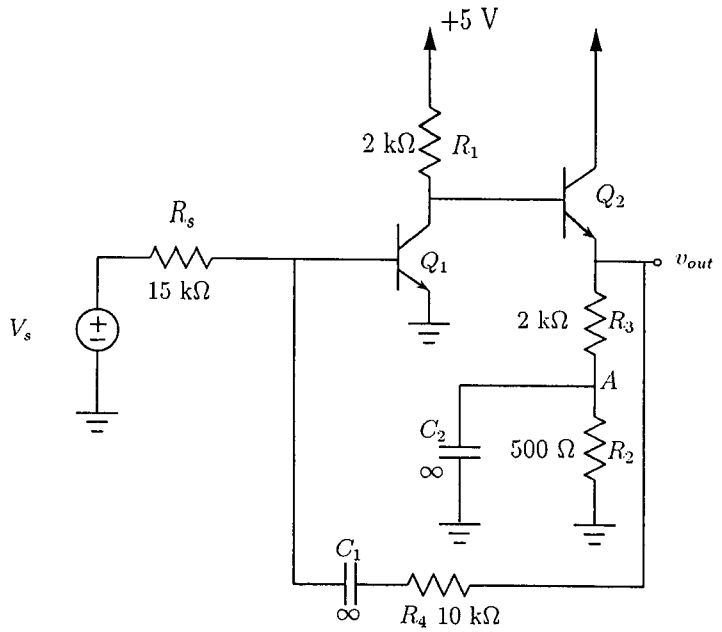
6. Consider the circuit shown below. The transistor Q_1 and Q_2 are identical with $\beta = 100$ and $V_{BE} = 0.7$ V. Assume the threshold voltage $V_{th} = 26$ mV.



(a) If the voltage at node A is 0.5 V, what are the DC bias points (I_C, V_{CE}) for Q_1 and Q_2?

(2%) I_{C1} = _____mA,

(2%) $V_{CE,1}$ =_____V,

(1%) I_{C2} = _____mA,

(1%) $V_{CE,2}$ =_____V.

(b) Determine the small-signal input resistance for Q_1 and Q_2 :

(2%) $r_{\pi 1}$ = _____Ω,

(2%) $r_{\pi 2}$ =_____Ω.

(c) (2%) If we consider v_{out} as the output, please specify the type of feedback topology of this circuit.

(d) (1%, True or False) This feedback operates at DC. Please explain your answer.

(e) (6%) Find the open-loop gain A =_____ .

(f) (3%) Find the loop-gain $A\beta$ = _____ .

(g) (3%) What is the closed-loop gain of this circuit?

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