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1. (15%) (a) (7%) The circuit shown in **Fig. 1.1** is biased with a constant-current source $I_Q$. The transistor has $\beta = 120$ and the E-B turn-on voltage is $V_{EB}(on) = 0.65V$. Determine $I_Q$ such that $V_{ECQ} = 3V$.

(b) (8%) Consider the circuit with $\beta = 120$ and $V_{BE}(on) = 0.7V$ as shown in **Fig. 1.2.** Design $R_1$ and $R_2$ such that $V_{CEQ} = 5V$.

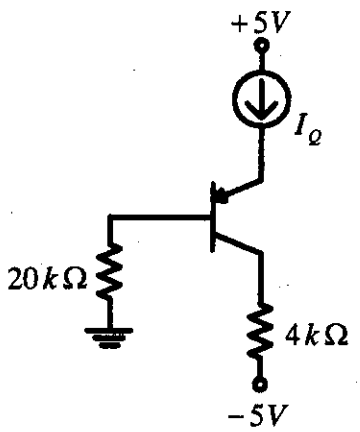


**Fig. 1.1**

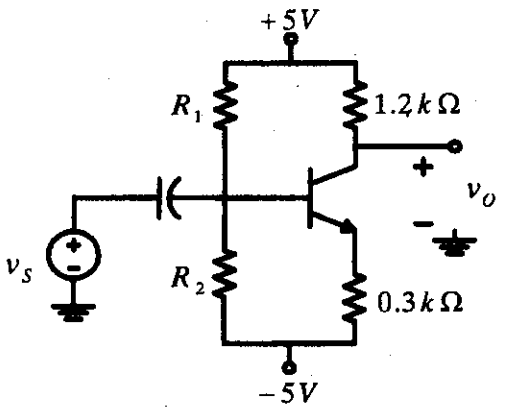


**Fig. 1.2**

2. (20%) A feedback amplifier is shown in **Fig. 2.** Assume that all transistors are matched and that $V_T = 25mV$, $\beta = 100$ (of the BJT), $I_{C_1} = I_{C_2} = 1.0mA$ and $r_o = \infty$. Please determine (a) (5%) $g_m$, $r_e$, $r_\pi$; (b) (5%) the voltage gain $v_2/v_1$; (c) (5%) the input resistance $R_i$; (d) (5%) the output resistance $R_o$.

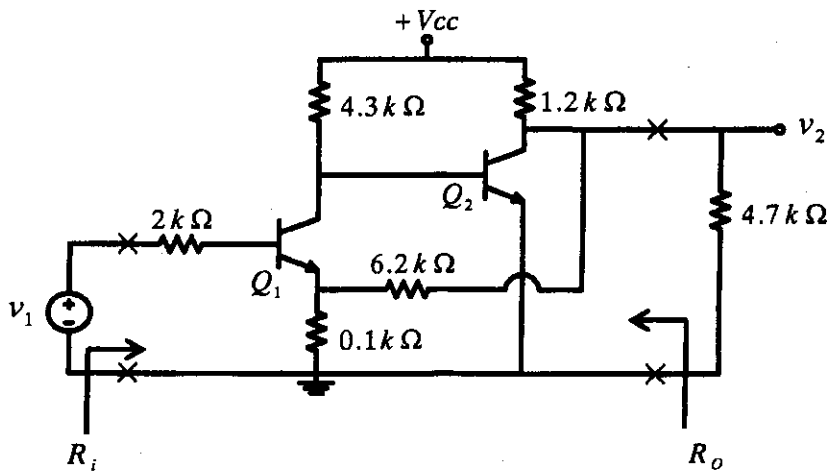


**Fig. 2**

(背面仍有題目,請繼續作答)

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3. (15%) Consider the circuit shown in **Fig. 3**. The two port circuit *A* has the hybrid parameters: $h_{11}=1\Omega$，$h_{12}=\frac{1}{3}$，$h_{21}=-3$ and $h_{22}=\frac{1}{3}\Omega^{-1}$. Please determine (a) (5%) the voltage gain $V_1/V_2$; (b) (5%) the voltage $V_2$; (c) (5%) the input resistance $R_i$.

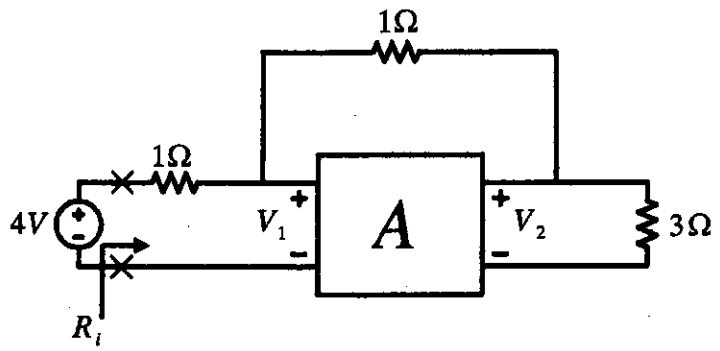


**Fig. 3**

4. (15%) Assume that the OP amp and diodes are ideal in the circuit of **Fig. 4**. (a) (8%) Please plot the transfer chacteristic ($v_o$ with respect to $v_i$) of the circuit. (b) (7%) If $v_i(t)=5\sin(2\pi t)$, please plot the output voltage $V_o(t)$ in the time domain.

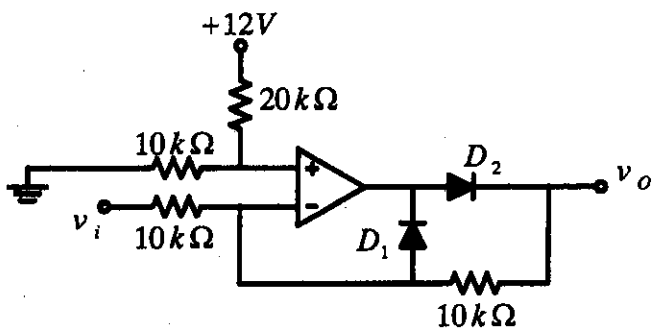


**Fig. 4**

5. (15%) (a) (10%) Assume that the op amp is ideal and all initial conditions are zero in the circuit of **Fig. 5**. (i) (5%) Please determine the transfer function $\frac{V_o(S)}{V_i(s)}$ of the circuit. (ii) (5%) Please derive the input-output differential equation in the time domain.

(b) (5%) Please design an analog circuit to solve the following differential equation (all initial conditions are zero)

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$$\frac{d^2 v_o(t)}{dt} + \frac{d v_o(t)}{dt} + v_o(t) = 1.$$

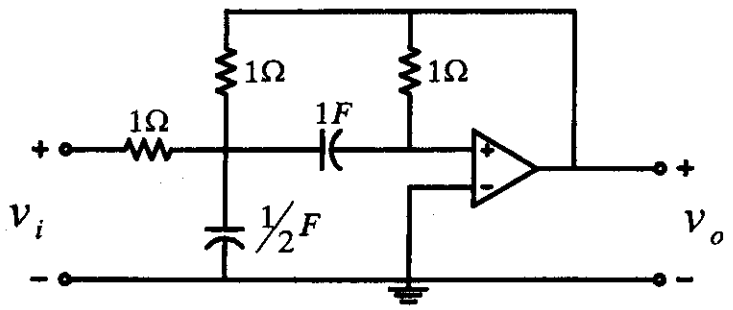


**Fig. 5**

6. (20%) Consider the differential amplifier in the **Fig. 6**, the component's characteristic as following, $Q_1$ and $Q_2$ are matched JFETs with $I_{DSS} = 2.5\ mA$, $V_P = -2\ V$ and $Q_3$ is the BJT with $\beta = \infty$. The input voltages of the JFETs, represented by $v_{S1}$ and $v_{S2}$, are only small signal without DC component.

   (a) (10%) Find the DC quiescent point ($I_{15.3k\Omega}$, $I_{C3}$, $V_{C3}$ and $V_{D2}$).

   (b) (10%) Determine the small signal voltage gain if the output is taken differentially. ($r_O = \infty$ for all the JFETs and BJT).

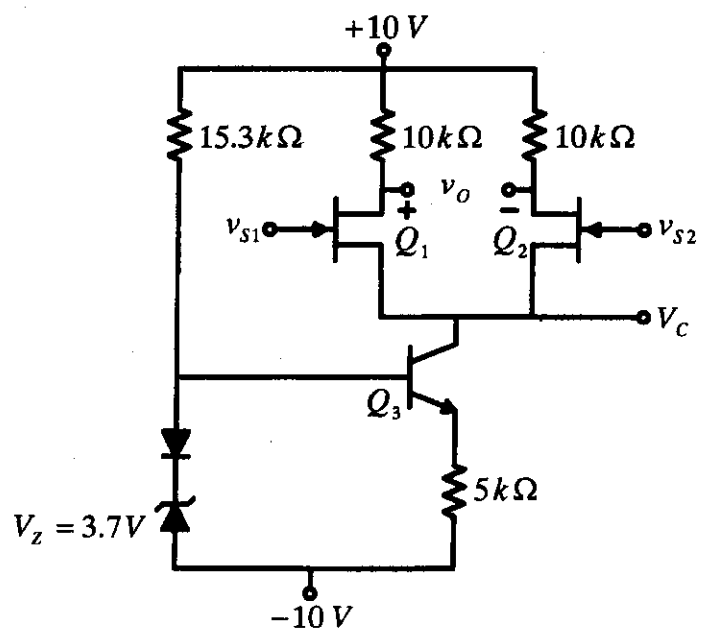


**Fig. 6**