國立台灣科技大學九十九學年度碩士班招生試題

系所組別： 電子工程系碩士班乙二組

科　　目： 電子學

（總分為100分）

1. For the circuit shown in Fig. 1, the BJT parameters are $V_A=\infty$, $V_{BE}(on)=0.7$ V, $\beta=100$, and $V_T=26$ mV. (a) (5%) Calculate the dc current I_B and I_C. (b) (5%) Draw the small-signal equivalent circuit of this circuit. (c) (5%) Find the small-signal voltage gain $A_V=v_{out}/v_{in}$. (d) (5%) Determine the small-signal input resistance r_{in} and the output resistance r_{out}.

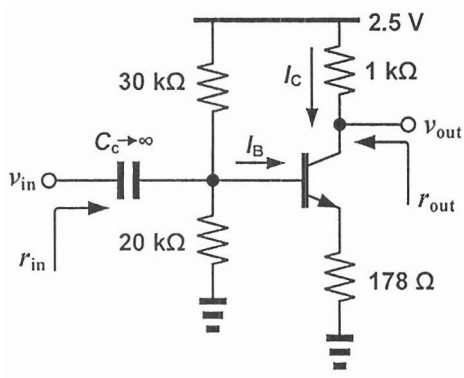

Fig. 1

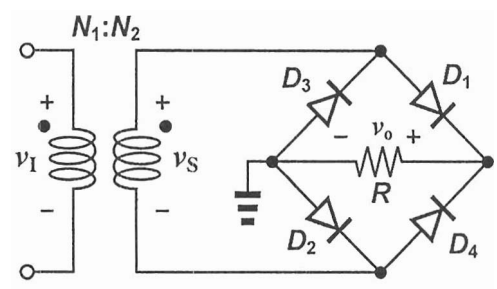

Fig. 2

2. The full-wave rectifier shown in Fig. 2 has a load resistor $R=150$ Ω. Assume the input voltage is from a 120 V_{rms}, 60 Hz ac source, the diode cut-in voltage is 0.7 V, and the desired output peak voltage v_O is 12 V. (a) (3%) Please find out the turns ratio N_1/N_2 of the transformer. (b) (3%) What is the peak inverse voltage (PIV) of each diode? (c) (4%) If the ripple voltage is to be smaller than 0.3 V, determine the required value of the filter capacitor in parallel with R.

3. For the circuit shown in Fig. 3, the NMOS transistors parameters are $V_{TN1}=V_{TN2}=0.5$ V, $K_{n1}=K_{n2}=1$ mA/V^2, and $\lambda=0$. The resistors values are $R_1=10$ kΩ, $R_{S1}=500$ Ω. (a) (9%) Determine R_2, R_{D1}, and R_{S2} such that $I_{D1}=I_{D2}=1$ mA, and $V_{DS2}=2.5$ V. (b) (5%) Find the small-signal voltage gain $A_V=v_{out}/v_{in}$. (c) (6%) Find the small-signal input resistance r_{in} and the output resistance r_{out}.

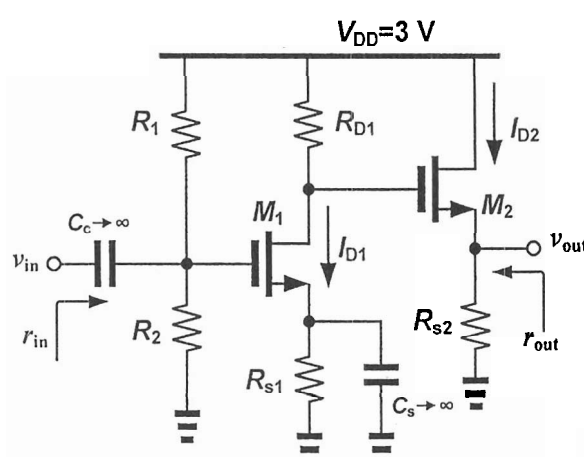

Fig. 3

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4. (8%) Determine the voltage gain $A_v = v_O / v_I$ for the ideal operational amplifier circuit in Fig. 4.

5. For the MOSFET differential amplifier circuit shown in Fig. 5. The transistor parameters are: $K_{n1} = K_{n2} = 0.1\ \text{mA/V}^2$, $K_{n3} = K_{n4} = 0.2\ \text{mA/V}^2$, $\lambda = 0.01$ and $V_{TN} = 1\ \text{V}$ for all transistors, and $R_D = 15\ \text{k}\Omega$, $R_1 = 30\ \text{k}\Omega$. (a) (5%) Calculate the dc current I_1, I_Q, and I_{D1}. (b) (7%) Determine the differential-mode voltage gain $A_d = v_{O2} / v_d$, where $v_d = v_1 - v_2$. (c) (7%) Determine the common-mode voltage gain $A_{cm} = v_{O2} / v_{cm}$, where $v_{cm} = (v_1 + v_2)/2$. (d) (5%) Find the CMRR for this differential amplifier.

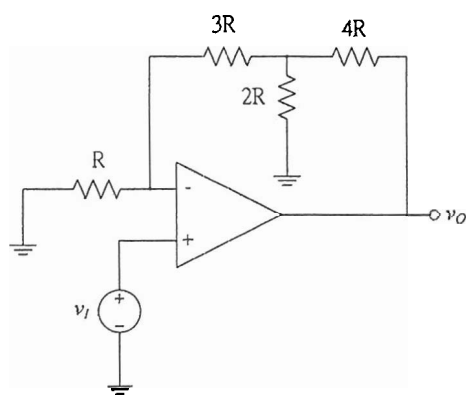

Figure 4

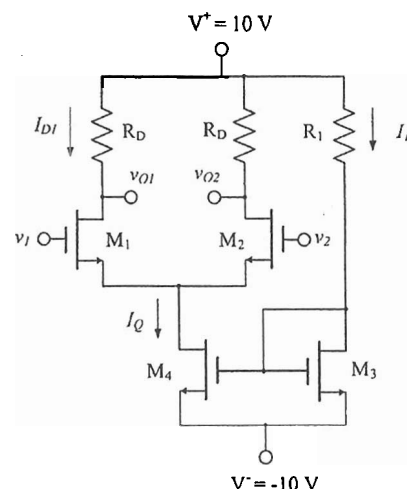

Figure 5

6. For the circuit in Fig. 6, $R_1 = 10\,k\Omega$, $R_2 = 100\,k\Omega$. The open-loop operational amplifier parameters are: input resistance $R_i = 60\,k\Omega$, voltage gain $A_v = 10000$. (a) (6%) Determine the feedback transfer function β. (b) (6%) Determine the close-loop gain A_{vf}. (c) (6%) Determine the close-loop input resistance R_{if}.

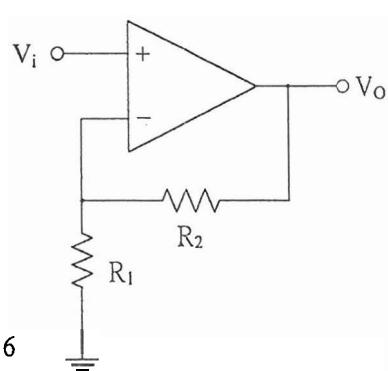

Figure 6