國立臺北科技大學 103 學年度碩士班招生考試

系所組別：1521 自動化科技研究所乙組

第三節　電子學　試題（選考）

注意事項：

1. 本試題共七題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. A transistor amplifier has the transfer characteristic

$$v_o = 10 - 10^{-11}e^{40v_I}$$

which applies for $v_I \geq 0\,\text{V}$ and $v_O \geq 0.3\,\text{V}$. Find the limits L_- and L_+ and the corresponding values of v_I. Also, find the value of the dc bias voltage V_I that results in $V_O = 5\text{V}$ and the voltage gain at the corresponding operating point. (12pts)

2. Consider an op amp using a bipolar junction transistor and having $f_t = 1\text{MHz}$ (unity-gain bandwidth), R_{id}=1MΩ (differential input resistance), R_{icm}=100MΩ (common-mode input resistance). Sketch an equivalent circuit of the input impedance of a non-inverting amplifier with a nominal gain of 100. (10pts)

3. Consider the circuit shown in Fig. 1. A string of three diodes is used to provide a constant voltage of about 2.1V. We want to calculate the percentage change in the regulated voltage caused by (a) a ±10% change in the power-supply voltage and (b) connection of a 1kΩ load resistance. Assume n=2 (the constant in the *i-v* diode equation). (10pts)

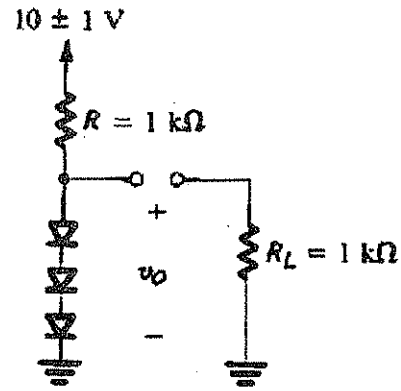

Fig. 1

4. The transistor in Fig. 2 is specified to have β in the range 50 to 150. Find the value of R_B that results in saturation with an overdrive factor of at least 10. (10pts)

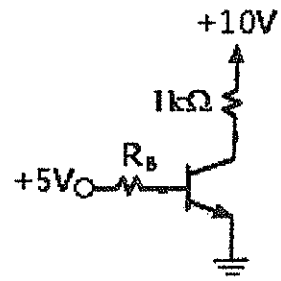

Fig. 2

5. Design the circuit in Fig. 3 to establish a dc voltage of +9.9V at the source. At this operating point, what is the effective resistance between source and drain of the transistor? Let $V_t = -1$V (threshold voltage) and $K = 0.5$ mA/V^2 (conductance parameter). (10pts)

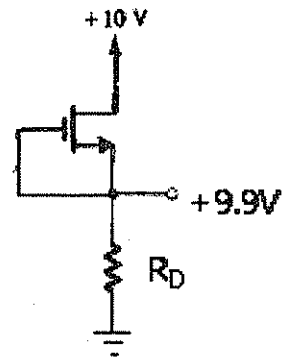

Fig. 3

6. Fig. 4 show the circuit of a simple operational amplifier. Terminals 1 and 2, shown

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connected to ground, are the op amp's input terminals, and terminal 3 is the output terminal.

(a)Assume $\beta \gg 1$ and $|V_{BE}| \approx 0.7$V. Find I_1, I_2, I_3, and I_4. Note Q_6 has four times the area of each of Q_9 and Q_3. (12pts)

(b)Calculate the quiescent power dissipation in this circuit. (8pts)

(c)If transistors Q_1 and Q_2 have$\beta = 100$, calculate the input bias current of the op amp. (8pts)

(d)What is the common-mode range of this op amp? (8pts)

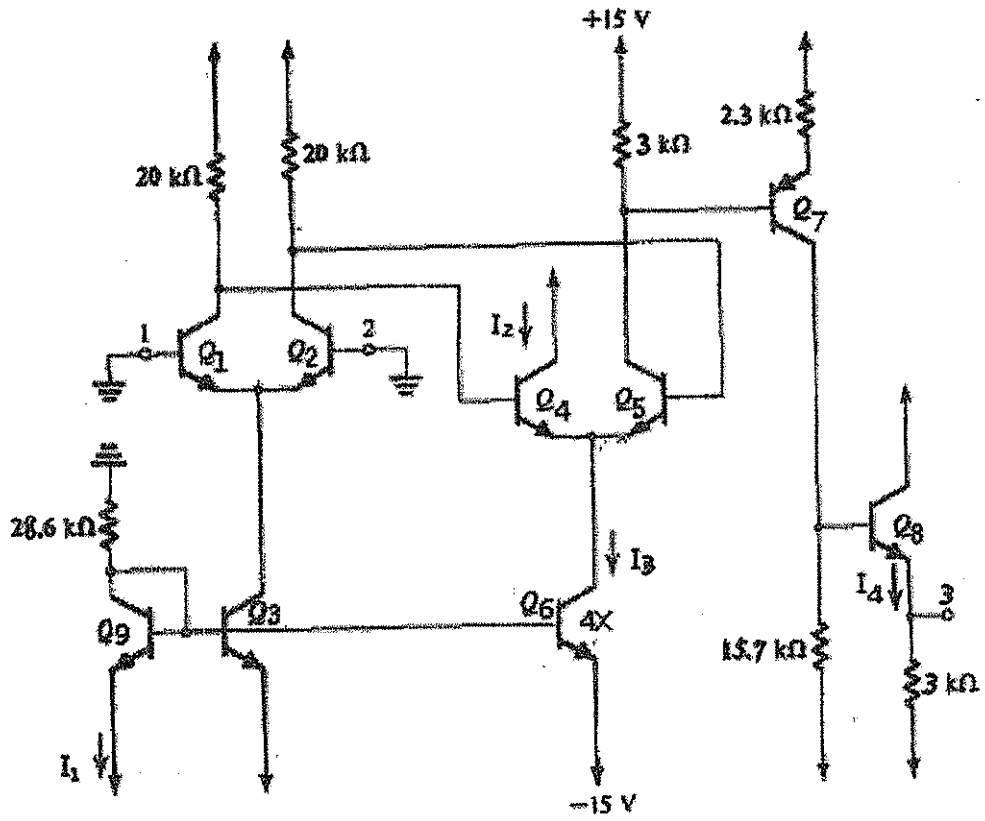

Fig. 4

7. The high-frequency response of an amplifier is characterized by the transfer function

$$F_H(s) = \frac{1 - \frac{s}{10^5}}{(1 + \frac{s}{10^4})(1 + \frac{s}{4 \times 10^4})}$$

Determine the 3-dB frequency approximately and exactly. (12pts)