國立臺灣科技大學
九十三學年度碩士班考試試題
系所組別：電機工程系乙二組、電機工程系丙二組
科　　目：電子學

總分 100 分

1. For the circuit shown in Fig. P1,
   (a) Express v_o as a function of v_1 and v_2. (5%)
   (b) What is the input resistance seen by a source connected between the two input terminals (differential mode)? (5%)
   (c) What is the input resistance seen by a source connected to both input terminals simultaneously (common mode)? (5%)

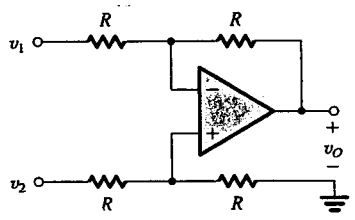

Fig. P1

2. For the circuit shown in Fig. P2, find V_B and V_E for v_I= +5V, -3V, -10V, respectively. The BJTs have β=100. (15%)

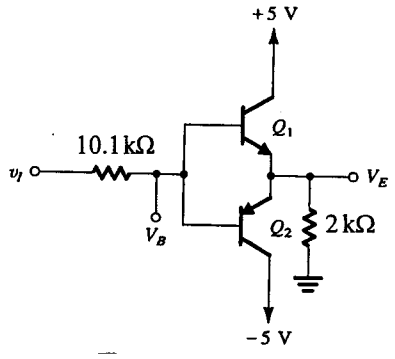

Fig. P2

3. Consider the circuit shown in Fig. P3 with two identical depletion-type MOSFETs(I_{DSS} = 4mA and $|V_t|$ = 2V) and three resistors. The function of Q_1 and R_1 is to establish the bias current for Q_2. It is known that Q_1 operates in saturation region when $v_i = 0$V.
   (a) What is the value of $k_n'W/L$ for these transistors? (3%)
   (b) For $R_3 = 4$kΩ and $R_1 = R_2$, determine the value of R_1 so that $I_{D1} = I_{D2} = 1$mA. (5%)
   (c) Draw the $v_o - v_i$ characteristics while v_i varies from -1V to +1V. (5%)
   (d) Give a suitable name for this circuit. (3%)

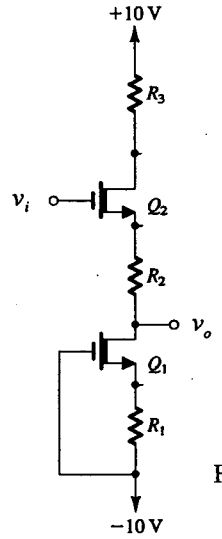

Fig. P3

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4. Consider the BiCMOS amplifier shown in Fig. P4. The BJT has $|V_{BE}| = 0.7\text{V}$, $\beta = 200$, $C_\mu = 0.8\text{pF}$ and $f_T = 600\text{MHz}$. The NMOS transistor has $V_t = 1\text{V}$, $k_n'W/L = 2\text{mA/V}^2$, and $C_{gs} = C_{gd} = 1\text{pF}$. After dc analyzing, the bias currents of Q_1 and Q_2 are $I_{D1} = 0.1\text{mA}$ and $I_{C2} = 1\text{mA}$, respectively.
   (a) Calculate the small-signal parameters g_{m1}, g_{m2} and $r_{\pi 2}$ of Q_1 and Q_2. (6%)
   (b) Determine the overall voltage gain V_o/V_s of the amplifier at midband frequencies. (5%)
   (c) Evaluate $C_{\pi 2}$ of Q_2. (3%)
   (d) Estimate the higher 3-dB frequency f_H of this amplifier. (5%)

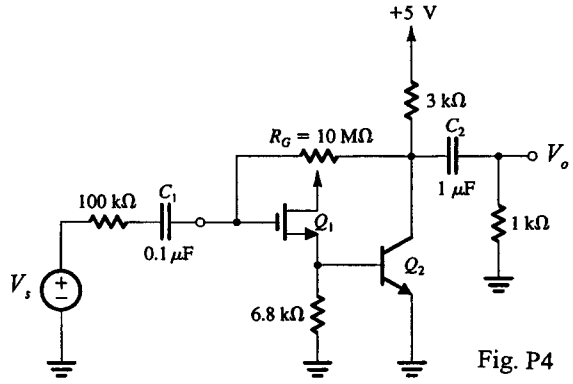

Fig. P4

5. A bridge amplifier configuration with high input resistance is shown in Fig. P5. Find the gain v_O/v_I. (15%)

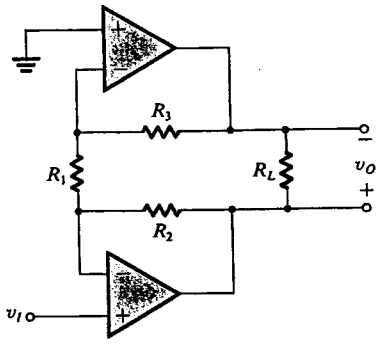

Fig. P5

6. A voltage signal source with a resistance $R_s = 10\text{ k}\Omega$ is connected to the input of a common-emitter BJT amplifier. Between base and emitter is connected a tuned circuit with $L = 1\ \mu\text{H}$ and $C = 200\text{ pF}$. The transistor is biased at 1 mA and has $\beta = 200$, $C_\pi = 10\text{ pF}$ (emitter-base capacitance) and $C_\mu = 1\text{ pF}$ (collector-base capacitance). The transistor load is a resistance of 5 kΩ. Find the Q factor and the center-frequency gain of this single-tuned amplifier. (20%)