國立臺灣師範大學 103 學年度碩士班招生考試試題

科目：電子學

適用系所：光電科技研究所

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

第 1~8 題為計算作圖題，必需運算過程及完整繪圖，第 9~14 題選擇題，無需計算過程

1. For the circuit shown in Fig. 1 using ideal diodes, find the values of I and V. (10 分)
2. For the OP-Amp shown in Fig. 2, find the relation between the output and input voltages. (10 分)
3. The transistor in Fig. 3 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. (10 分)

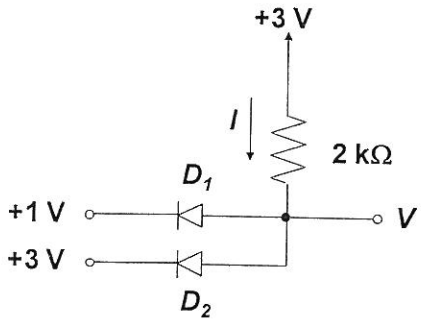

Fig. 1

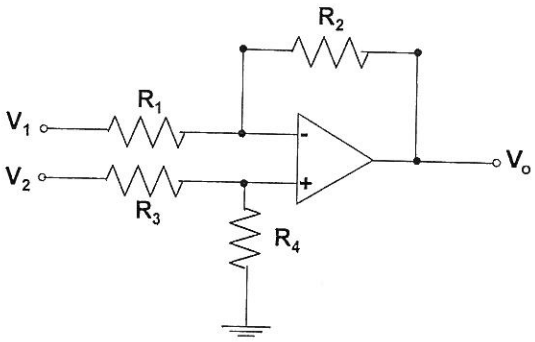

Fig. 2

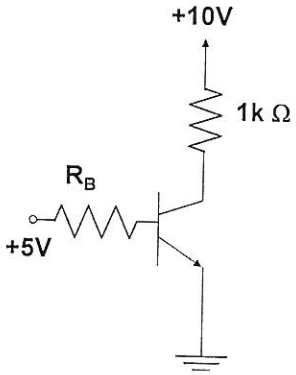

Fig. 3

4. The circuit shown in Fig. 4 represents the equivalent circuit of an unbalanced bridge. Note $R_1 = 1$ kΩ, $R_2 = 2$ kΩ, $R_3 = 3$ kΩ, $R_4 = 4$ kΩ, and $R_5 = 5$ kΩ. It is required to calculate the current in the detector branch (R_5) and the voltage across it. Although this can be done using loop and node equations, a much easier approach is possible: Find the Thevenin equivalent of the circuit to the left of node 1 and the Thevenin equivalent of the circuit to the right of node 2. Then solve the resulting simplified circuit. (10 分)
5. Design the circuit (find the R_S and R_D) of Fig. 5 so that the transistor operates at $I_D = 0.4$ mA and $V_D = +1$ V. The NMOS transistor has $V_t = 2$ V, $\mu_n C_{ox} = 20\ \mu A/V^2$, $L = 10$ μm, and $W = 400$ μm. Neglect the channel-length modulation effect. (10 分)
6. Please draw (a) The high-frequency equivalent circuit model for the MOSFET. (4 分) (b) The equivalent circuit for the case the source is connected to the substrate (body) of MOSFET. (3 分) (c) The equivalent circuit of (b) with C_{db} neglected (to simplify analysis). (3 分)
7. Please make a description of high-speed devices with III-V (such as GaAs), not Si. (5 分)

8. Please plot the circuit symbol (a) p-n diode (1 分); (b) pnp transistor (1 分); (c) NMOSFET & PMOSFET (1 分); (d) Schottky diode (1 分); (e) tunneling diode. (1 分)

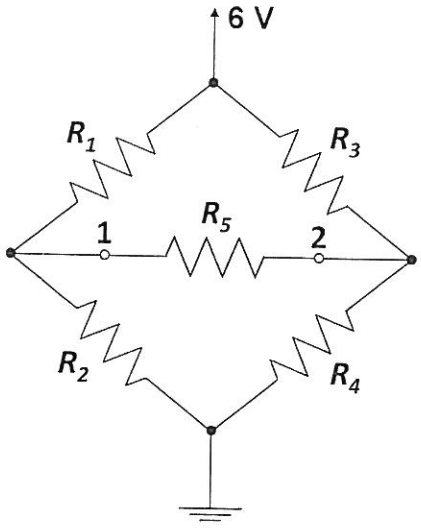

Fig. 4

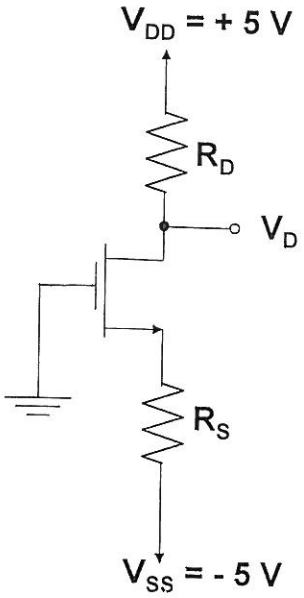

Fig. 5

9. Find the frequency f and ω of a sin-wave signal with a period of 1 ms. (1) $f = 100$ Hz; $\omega = \pi \times 10^3$ rad/s (2) $f = 100$ Hz; $\omega = \pi \times 10^2$ rad/s (3) $f = 1000$ Hz; $\omega = \pi \times 10^3$ rad/s (4) $f = 1000$ Hz; $\omega = 2\pi \times 10^3$ rad/s (5) $f = 1000$ Hz; $\omega = 2\pi \times 10^2$ rad/s (5 分)

10. The definition of CMRR (common-mode rejection ratio) is (1) A_c/A_d (2) A_d/A_c (3) V_c/V_d (4) V_d/V_c (5 分)

11. For an ideal OP-Amp, its input impedance (R_i) and output impedance (R_o) are: (1) $R_i=0$, $R_o=0$; (2) $R_i=0$, $R_o=\infty$; (3) $R_i=\infty$, $R_o=0$; (4) $R_i=\infty$, $R_o=\infty$; (5) not defined. (5 分)

12. Consider a silicon diode with n = 1.5. Find the change in voltage if the current changes from 0.1 mA to 10 mA. (1) 0.1725 mV (2) 1.725 mV (3) 17.25 mV (4) 172.5 mV (5) 1725 mV (5 分)

13. The emitter, base, and collector voltages of an *npn* transistor are -0.7 V, 0 V, and -0.6 V, respectively. Please identify the mode of operation of the transistor. (1) saturation (2) active (3) inverted (4) cut off (5 分)

14. Compared to a MOS device, a bipolar device has (1) higher input impedance (2) lower transconductance (3) lower standby power consumption (4) current dominated by drift current (5) higher current driving capability (5 分)