系級班別：＿＿＿＿＿＿＿　　　　學號：＿＿＿＿＿＿＿＿　　　姓名：＿＿＿＿＿＿＿

(無參考資料，可用計算機) 請在答案卷右上方畫上成績欄，謝謝。

(20%) 1.　(a) Derive I_{out} as a function of I_{REF}, K and R in Fig.1a, where $K = \dfrac{u_n C_{ox}}{2}\left(\dfrac{W}{L}\right)$. (10%)

　　　　(b) Calculate the current I_{C10} when I_{REF}=1mA and R_4=5kΩ are given in Fig. 1b. Thermal voltage V_T = 25mV is assumed. Q_{10} and Q_{11} are identical, i.e. saturation current $I_{S(Q10)} = I_{S(Q11)}$. (10%)
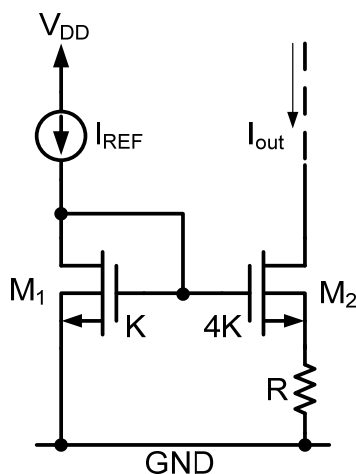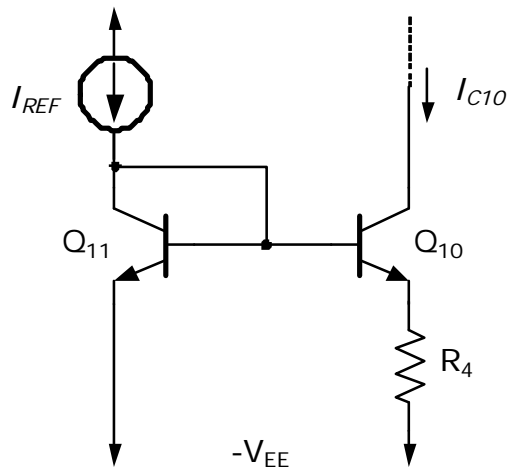

Fig. 1a　　　　　　　　　　　　　　　Fig. 1b

(20%) 2. (a) A charge-redistribution circuit is initially connected as in Fig. 2a and then the circuit is connected as in Fig. 2b. Find the node voltage V_x in Fig. 2b where V_{in}=1V and V_{ref}=5V. (10%)

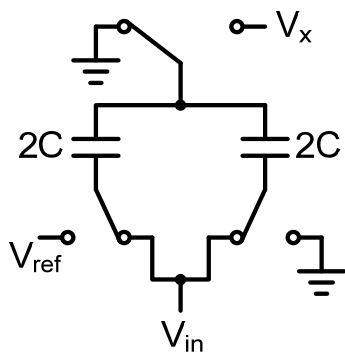　　　　(b) Describe the operational principle of a 2-bit R-2R D/A converter. (10%) (Illustration is needed.)
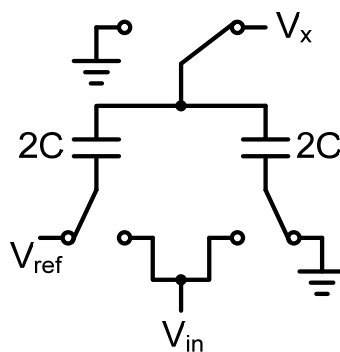

Fig. 2a　　　　　　　　　　　　　Fig. 2b

(10%) 3. Derive the normalized polynomial T(s) of a 2nd-order Butterworth filter with ε = 1.

　　(Butterworth transmission function=$\dfrac{1}{\sqrt{1+\varepsilon^2\left(\dfrac{\omega}{\omega_p}\right)^{2N}}}$)

(20%) 4. (a) Using a simple (r_π, g_m) model for each of the two transistors Q_{18} and Q_{19} in Fig. 4a, find the small-signal resistance between A and A'. Thermal voltage $V_T = 25mV$, $\beta_{npn}=200$, $\beta_{pnp}=50$, $I_{C18}=165uA$ and $I_{C19} \fallingdotseq 16uA$ are assumed. (10%)

(b) Fig. 4b shows the circuit for determining the OPAMP output resistance when v_o is positive and Q_{14} is conducting most of the current. Using the resistance of Q_{18}-Q_{19} network calculated in (a) and neglecting the large output resistance of Q_{13A}, find R_{out} when Q_{14} is sourcing an output current I_{out} of 5mA. $\beta_{npn}=200$, $\beta_{pnp}=50$. (10%)
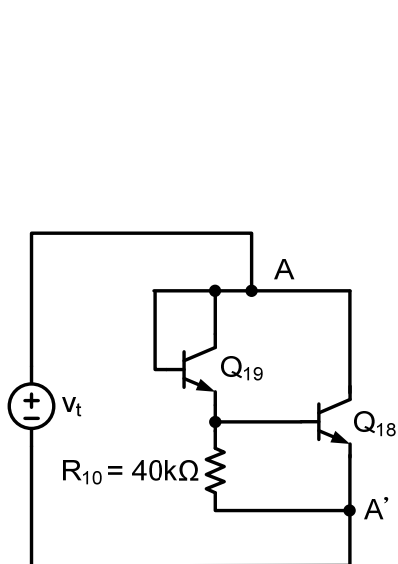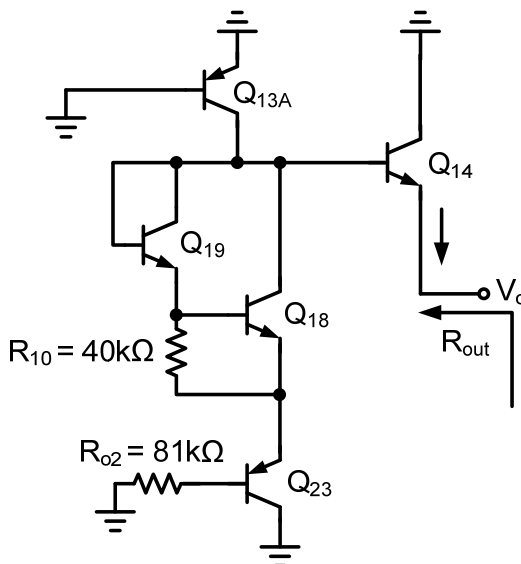

Fig. 4a   Fig. 4b

(20%) 5. (a) For a KHN circuit shown in Fig. 5a, please describe the functions of V_a, V_b, V_c nodes and briefly explain the operational principle of the KHN circuit. (10%)

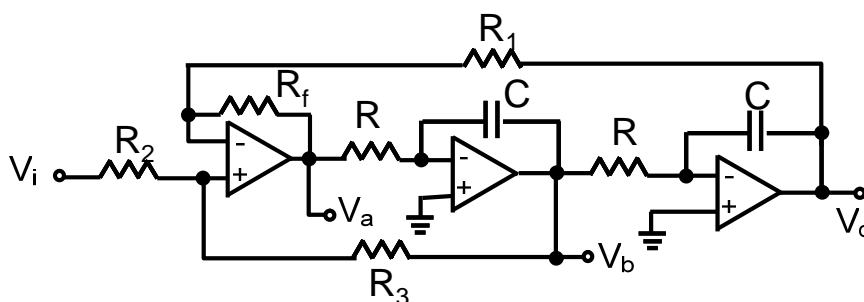(b) Draw a Tow-Thomas circuit and explain its operational principle. (10%)

Fig. 5a

(20%) 6. Switched-capacitor (SC):

(a) Explain why a switched-capacitor circuit can behave as a resistor? (10%)

(b) Draw the circuit diagram of a stray-insensitive SC integrator, which is either inverting or noninverting. Explain why it is stray-insensitive? (10%)