1. (15 %)Describe the characteristics of the following terms:
   (a) Surface Mount Device (SMD);(b) Ball Grid Array (BGA);
   (c) Electronic Design Automation (EDA);(d) Flash memory;
   (e) Gallium-Arsenide (GaAs) digital circuits.

2. (15 %) For the PNP differential amplifier circuit (Fig.1), let $V_{CC} = 15V$, R_C=15 $K\Omega$, R_B = 10 $K\Omega$, and R_{EE}= 50 $K\Omega$.
   (a) Draw the equivalent circuit of the differential amplifier;
   (b) Find the common mode gain and Derive the CMRR of the differential amplifier.

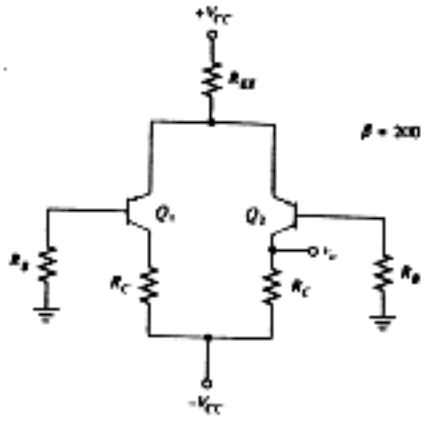

Fig. 1

3. (20 %) Assumed that the op-amps in Fig. 2 are ideal.
   (a) Derive the transfer function of the high pass filter. You can solve the R-C network by assuming V_+=V_o and using KCL theorem.
   (b) What is the high-frequency gain ?
   (c) Design the circuit for a maximally flat response with a 3-dB frequency of 1000 rad/s. By using C_1=C_2=10 nF, please give the values for R_3 and R_4. (Hint: The polynomial of the active filter is equal to $s^2/\ (s^2 + s\ (\omega_0/Q) + \omega_o^2)$. For a maximally flat response, Q=$1/\sqrt{2}$ and ω_{3dB}=ω_0.)

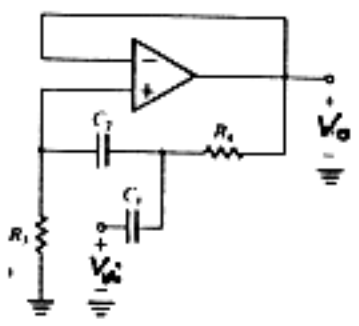

Fig. 2

4. (20%) Fig. 3(b) shows a simple astable multivibrator circuit using CMOS gates. The finite output resistance of the CMOS gate can be neglected. Also, the diodes at the gate input are assumed ideal.
   (a) Using the waveform V_{O1} in Fig. 3(a), please verify the period T = CR $ln\ (V_{DD}^2\ /\ (V_{DD}V_{th}\text{-}V_{th}^2))$. V_{th} denotes the threshold voltage.
   (b) Plot the waveform in v_{I1} and label the V_{th}, V_{DD}, and T.
   (c) Find suitable values for R and C to obtain oscillation f_o = 72.1 KHz.

5. (15 %) Please use a single type of digital gate (e.g. AND, OR, NAND,or NOR gates) to realize (a) RS flip-flop;(b) D-type flip-flop. Also, give their truth tables.

6. (15 %) A clinical neurologist in National Cheng Kung University Hospital wishes to set up a digital controlled contstant current source for nerve stimulation. Assumed that the desired current is between 0 - 31 μA with an increment of 1 μA (i.e. current resolution). Please give your design by using D/A and constant current source.
   (a) Draw your circuit design of the D/A converter, for example, by using either binary-weighted R, R-2R, or other configurations. Explain your selection criteria.
   (b) Describe your design methods for the constant current source.

Fig. 3(a)

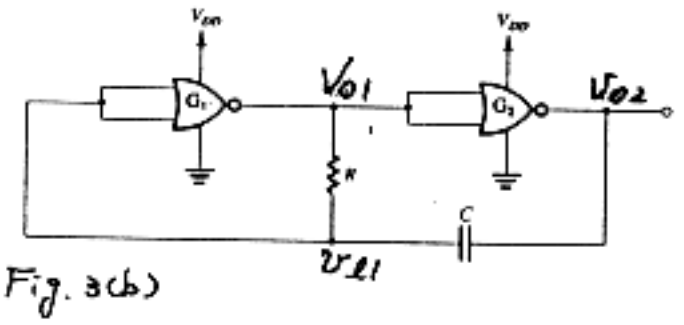

Fig. 3(b)