

- (15%) Describe the following terms:
 - Miller effect;
 - Intellectual Property (IP);
 - System on a chip (SOC);
 - BiCMOS;
 - Simulation Program with Integrated Circuit Emphasis (SPICE).
- (20%) Figure 1 shows the 555 timer for implementing an astable multivibrator. The exponential rise of v_c can be described by

$$v_c = V_{CC} - (V_{CC} - V_{TL}) \exp(-t/C(R_A + R_B))$$

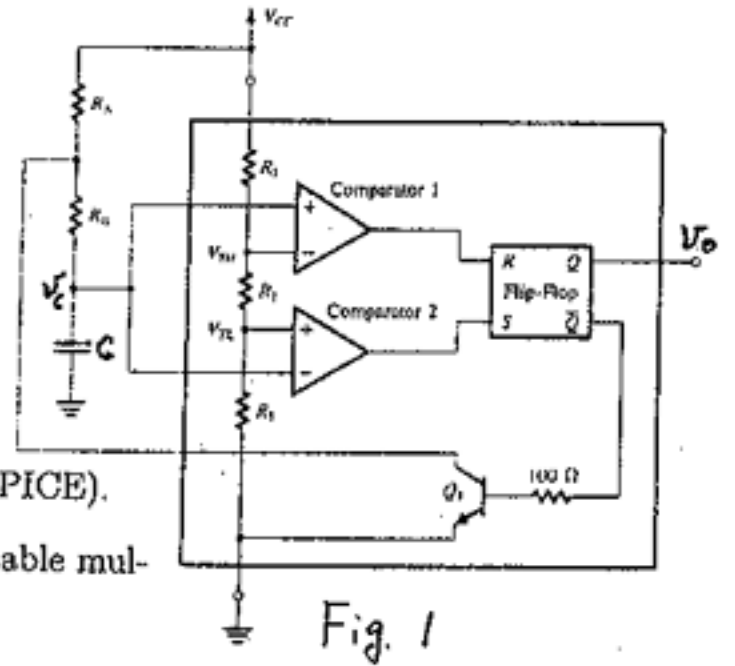


Fig. 1

- Draw the v_c and v_o and describe the system operation. Label the V_{TH} and V_{TL} on the plot of v_c .
 - Derive the exponential fall of v_c .
 - If the desired duty cycle is 0.75 with oscillation frequency of 100 KHz, give the appropriate values of R_A , R_B , and C .
- (20%) For Q_N and Q_P in Fig. 2 with the following conditions: $V_{CC}=15\text{ V}$, $V_{BE(ON)} \cong 0.7\text{ V}$, $V_{CE(SAT)} \cong 0.5\text{ V}$, and $\beta \cong 100$

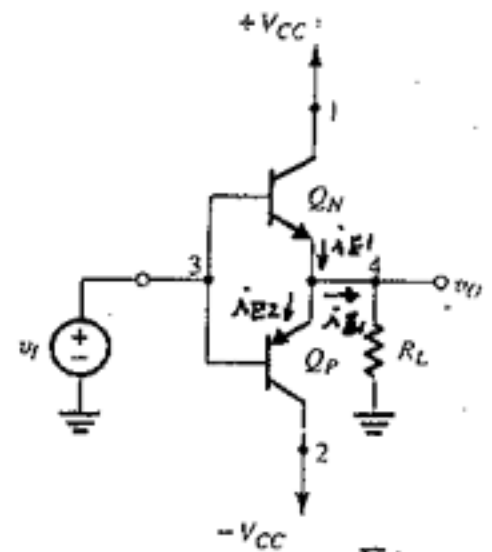


Fig. 2

- Sketch v_o versus v_i . Label levels and slopes.
 - If $v_i = 10 \sin \omega t$, sketch i_{E1} , i_{E2} , and i_L with $R_L=100\ \Omega$.
 - Under the conditions in (b) approximate the power conversion efficiency.
- (15%) for Q_1 in Fig. 3: $\gamma_\pi=500$, $g_m = 0.1\text{ U}$, $g_m \gamma_\pi = \beta$, $C_\pi = C_\mu = 0$.
 - Draw the small signal equivalent circuit.
 - suppose the frequency of v_s is varied. What are the maximum value and the minimum value of the voltage gain $|v_o/v_s|$?
 - (15%) Please design a high-pass active filter with a corner frequency of 10^4 rad/s and a high frequency-frequency gain of 10 using an ideal op-amp.
 - Please draw the circuit with appropriate R-C values.
 - Give the transfer function and show the Bode plot. Label the zeros and poles on the s-plane.
 - (15%) A clinical physician wishes to perform a research by continuously collecting the blood pressure signal of patient for at least 24 hours. Assumed that the highest frequency of the blood pressure signal is about 50 Hz. Could you design a PC-based data acquisition system for this purpose? Please give your specifications on the type of analogue-to-digital converter (ADC), the sampling rate, the communication between ADC and PC, the memory storage required, and other system hardware for this study.

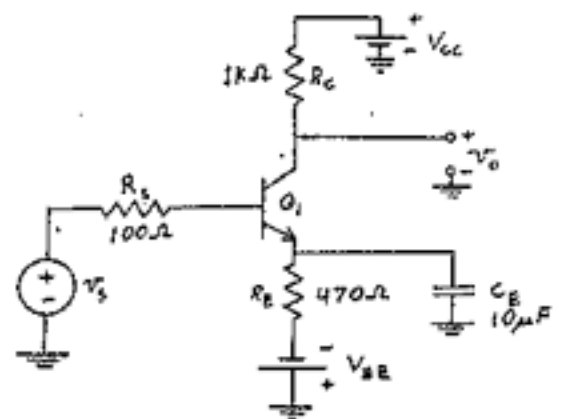


Fig. 3