本試題是否可以使用計算機：☑可使用 ，□不可使用 （請命題老師勾選）

1. (15 %) Explain the terminologies generally used in microelectronics:

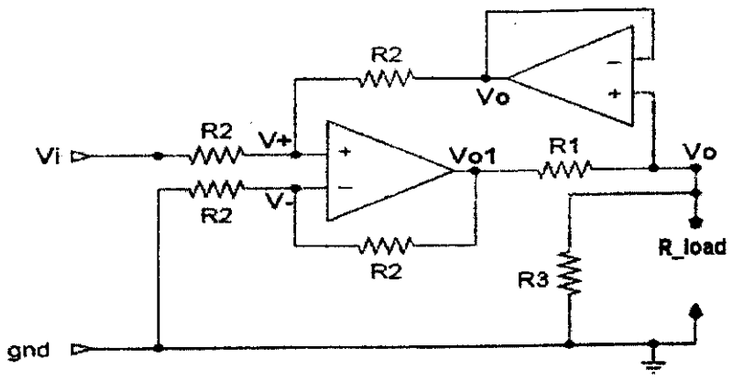
(a) Opto-isolator

(b) Register transfer logic (RTL) in IC design

(c) VHDL in IC design

(d) Electronic design automation (EDA)

(e) Switched-capacitor integrator



(Figure 1)

2. (15 %) Figure 1 is a modified Howland amplifier which has been designed to be a constant current pump (source) or a voltage to current converter.

(a) Please show that the current across R1 is independent of R_load and R3.

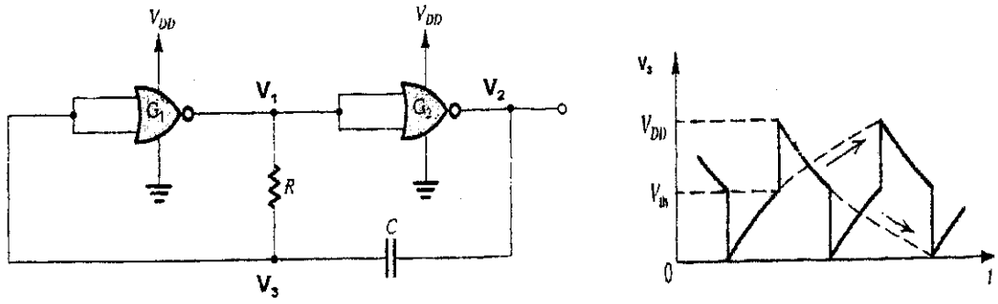
(b) Based on the modified Howland amplifier above, we wish to design a micro-processor controlled constant current mono-phase pulse of 300 μs pulse width with 4096 steps current outputs at 1 kHz. Please draw your design in block diagram with necessary specifications. You can make any assumptions and use components that you are familiar with.

3. (20 %) Figure 2 shows a simple astable multivibrator using two ideal NOR CMOS gates.

(a) Please draw the output of V_2 with reference to V_3 on the right hand side of Fig. 2.

(b) Derive the period (T) of the astable multivibrator in terms of RC, V_{DD} and V_{th}.

(c) Please give your design such that the frequency of the astable multivibrator will be 1 kHz.



(Figure 2)

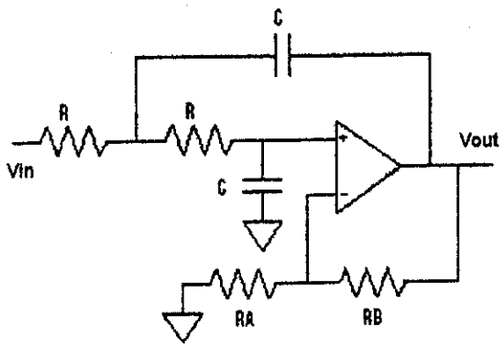
(背面仍有題目,請繼續作答)

4. (15 %) Sallen-Key filter is one of common filters with a single op-amp, as shown in Fig. 3.

(a) Calculate the DC gain, K.

(b) Derive the Vout/Vi

(c) Give your components that meet the requirement of a low pass filter at cut off frequency of 1 kHz.



(Figure 3)

5. (15 %) In our laboratory, we wish to design a phase detector that can measure the phase difference between two sinusoidal waveforms at the same frequency.

(a) First, please draw your design of a Wien bridge oscillator (or any other kind) that can generate sine wave source of 1 kHz.

(b) Draw your design of the phase detector with the input and output signals.

Describe your design considerations.

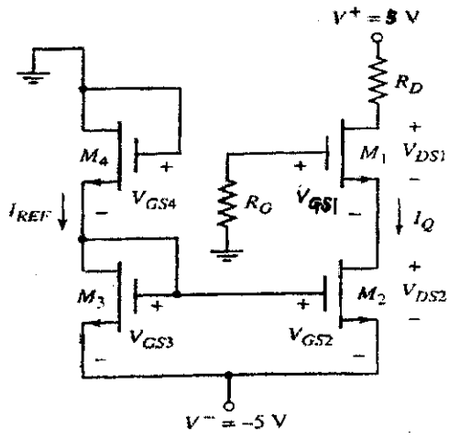
6. (20%) As shown in Fig. 4, a MOFET can be biased by a constant-current source I_Q. The threshold voltage of the n-channel MOSFET is denoted as V_{TN}. The conduction parameter for the n-channel transistor is denoted as K_n. M2, M3, and M4 with transistor parameters K_{n2}, K_{n3}, K_{n4}, form the current source.

We can write $K_{n3}(V_{GS3}- V_{TN3})^2 = K_{n4}(V_{GS4}- V_{TN4})^2$

(a) Determine I_Q in terms of K_{n2}, V_{GS3}, V_{TN2}

(b) Assume that the threshold voltage of each transistor is V_{TN}=1 V. Design the ratio of transistor parameters of M4 and M3, K_{n4}/K_{n3} such that V_{GS3} = 2 V.

(c) Determine the transistor parameter of M2, K_{n2} such that I_Q = 100 μA.



(Figure 4)