

1. (15 %) (a) Please draw a block diagram of positive feedback loop, frequency-selective network, and any other required components to explain the basic principles of sinusoidal oscillators ?  
 (b) Design an oscillator at your choice with resonant frequency at 1 kHz.

2. (15%) To realize the analogue filter with two alternative structures, shown in Fig. 1. for the following specifications: a zero at 800 Hz and a pole at 13 kHz, and a high-frequency gain of 20dB. Please derive the transfer functions and values of R and C.

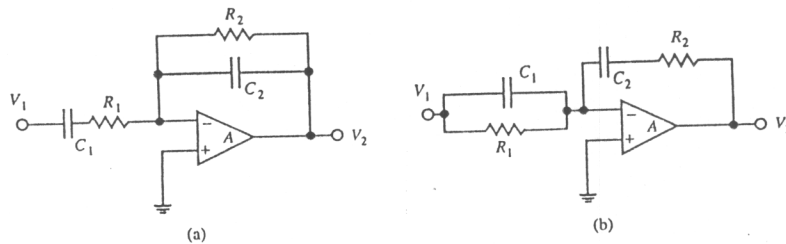


Figure 1.

3. (20 %) (a) Digital phase detector is commonly used in medical instrumentation and phase-locked loop. Please explain working principle of a dual-D flip-flop phase detector, shown in Fig. 2, under the case in which  $f_2=2f_1$ . Please draw the output in Q2 and v. when  $f_1$  lags  $f_2$  or  $f_1$  leads  $f_2$ .  
 (b) A simple XOR can also be used a phase detector. Can you draw the circuit and the output of phase detector under the conditions in which  $f_1=f_2$  and  $f_1$  might lag or lead  $f_2$  ? Draw the output voltage as a function of the phase error for the XOR circuit.

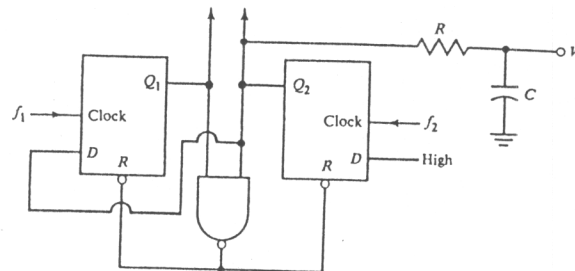


FIGURE: 2.

4. (10%) Describe the Einstein relationship for  $p$ -type and  $n$ -type semiconductors.
5. (10%) Draw the high-frequency small-signal model for FET and explain the significance of each element.
6. (15%) Sketch the circuit of a bridge rectifier and explain its operation.
7. (15%) Define sheet resistance.