**Laboratory 8**

**A**: /5**B**: /4**C**: /6 **Tot:** /15

**Relaxation Oscillators**

This lab consists of three modules. We will see how parasitic effects can occasionally be used to a designer’s advantage

**Part A: Capacitor connected at Input**

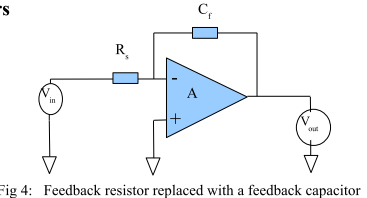


Fig 1: *Cs* at source

Cs

Rf

Consider the circuit of Fig 1. Notice the difference from standard inverting feedback amplifier: the *source* resistor has been replaced by a capacitor *Cs.*

/1

/2

/2

**Q1:**Calculate the *time-domain* response of *Vout* to *Vin* as in Part A. The time-domain response requires you to apply the golden rules of opamp design *and* the current-voltage relationship for a capacitor I = C dV/dt followed by some algebra.

**Q2:** Choose suitable values of the passive components Rs ,Cf such that the time constant of your design is 1 ms.

**Q3:** Build the circuit of Fig 2 and drive it with a *square Vin* of amplitude 2V peak-to-peak.   
Note that *Cs* is in the signal path, so the type of capacitor used is important. Choose wisely!  
Draw a diagram of your observations here and verify that your calculations of Q1 above are correct.

**Part B: Comparator**Recall the simple comparator (with hysteresis) circuit using positive feedback we studied earlier in Lab 2. The function of a comparator is to feedback a fraction of *Vout* to the **(+)** input so that when *Vin* exceeds a threshold set by the feedback fraction *Rf+/R+*, the output switches to -Vsat and when *Vin* falls below threshold, output switches to +Vsat

Use your memory/logic and draw the diagram of a simple comparator circuit here:

Fig 2: Simple comparator with positive feedback. Set the reference voltage for comparison to Vsat \*(R+/Rf++ R+). You may choose Rf+ = R+

**Q1:** For *Vin*= 0, *predict* the values of *Vout* in your circuit:  
  
 a) What is *V­­out* at t=0 immediately when the circuit is turned on?   
   
  
 b) For an *ideal* power supply that turns on +/-V­cc­ as a step function, what is *Vout* in the   
 very short time ~ microseconds after the circuit is turned on?

/0.5

/1

/0.5

/0.5

c) What is *Vout­* in steady state after the circuit has been on for a few seconds:

d) What determines the steady state value of *Vout* in question c) ?

/0.5

**Q2:** Connect up the circuit you have designed in Fig 2 and *demonstrate* the validity of your predictions  
Use this space to record your DSO observations of *Vout* in detail.   
**Note that *Vin = 0* for a), b), c)**Your observations for (b) may differ from prediction because the power supply is *not* ideal. Observe the voltage +/-V­cc supplied by the power supply to the circuit at t=0 on the DSO to validate your prediction.

/2

**Part C: Relaxation oscillator**

Use your observations and conclusions from Parts A and B to make a circuit *with one opamp* that demonstrates the following behavior:  
  
1. It’s *Vout* oscillates between two fixed values (for example *+Vsat* and *-Vsat )*2. It has no external *Vin* applied   
3. The oscillation time period is 1 ms

*Hint: You will need to combine the concepts of Parts A and B*

Draw your circuit design here. Calculate and mark the value of the components required.

/3.5

/2.5

This type of oscillator is called a ‘Relaxation Oscillator’. Build your circuit and demonstrate its operation