

**UNIVERSITY OF CALIFORNIA**  
**College of Engineering**  
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**Homework 2**  
**Due Thursday, September 29, 2005**

**EECS 247**  
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**Problem 1:**

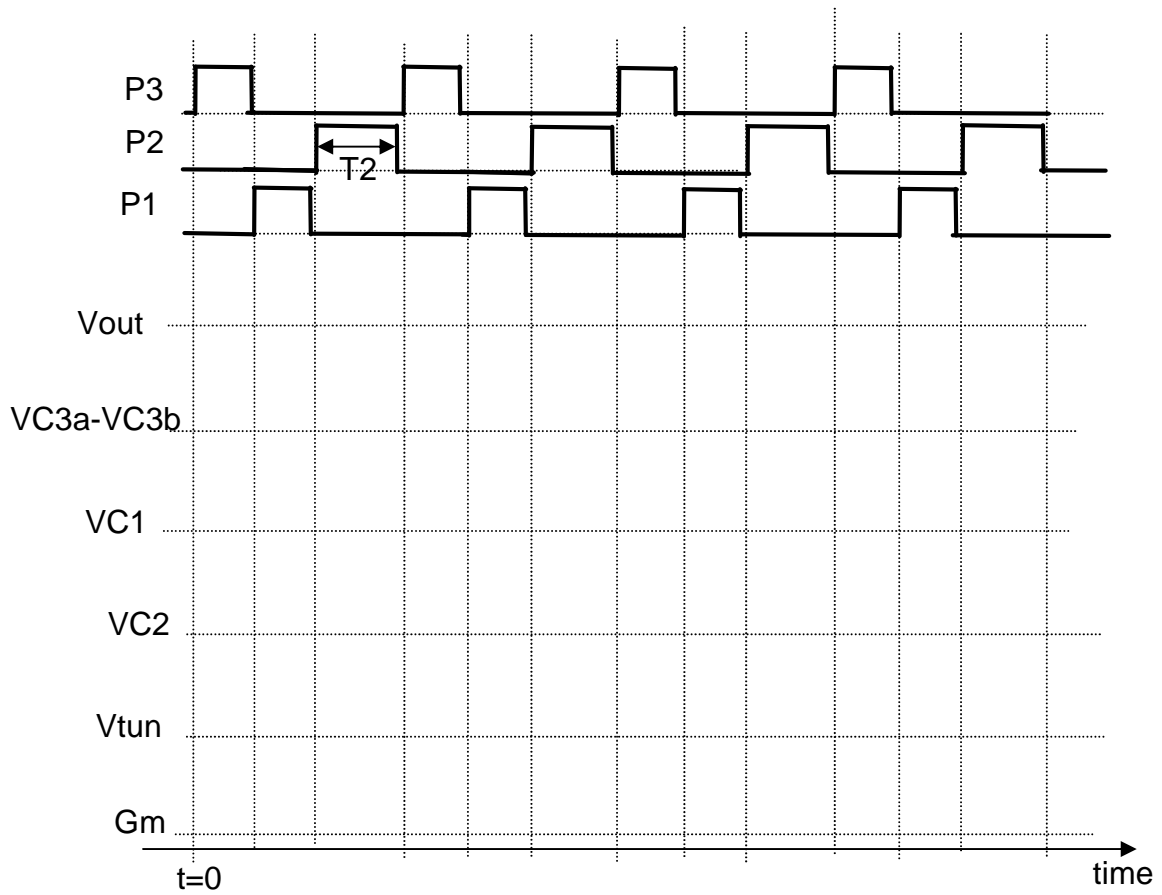
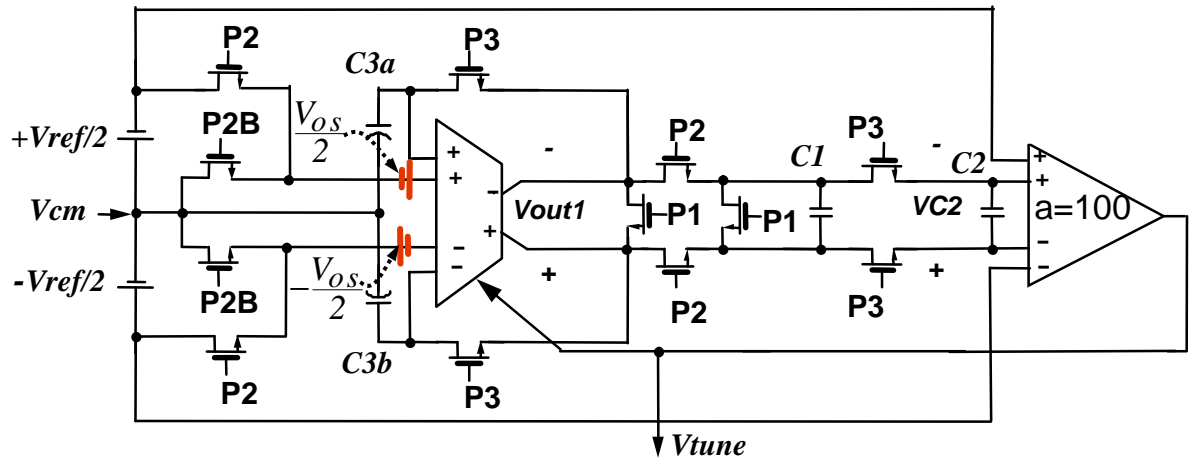
Consider the circuit shown in below (lecture 7). Assume the following:

1. The circuit is turned on at  $t=0$ . Prior to this time, all the capacitors are discharged and  $V_{tune}=0$
2.  $C_2=2C_1=10\text{pF}$ ,  $V_{ref}=0.5\text{V}$
3. The auxiliary input pair added for offset cancellation purposes has input transconductance equal to  $1/8$  compared to the main input transconductance.
4. In this example, the main input has an offset voltage equal to  $10\text{mV}$ , for simplicity, assume offset is appears on the main input as a differential signal (pay attention to the polarity of the voltage source shown in the figure below).
5.  $T_2=100\text{nsec}$ , and P2B is inverted P2
6. The integrator transconductance can be modeled as:  
 $G_m=4 \times 10^{-5}[\text{A/V}] + (V_{tune} \times (2 \times 10^{-5}[\text{A/V}^2]))$
7. Assume ( $V_{tune}=100 \times V_{in}$ ) for the mid input range of  $0 < V_{in} < 0.01$  and that the voltage range for  $V_{tune}$  is limited to maximum of  $1\text{V}$  and minimum of  $0\text{V}$ . In other words for  $V_{in} < 0$   $V_{tune}=0$  and for  $V_{in} > 0.01$ ,  $V_{tune}=1\text{V}$ . Note that  $V_{in}=V_{ref}-VC_2$

Fill in the diagram shown below. Pay attention to charge conservation during charge sharing between the capacitors  $C_1$  &  $C_2$ .

Show values for  $V_{out1}$ , ( $VC_{3a}-V_{c3b}$ ),  $VC_1$ ,  $VC_2$ ,  $V_{tune}$ , and  $G_m$  for four cycles after startup on the diagram provided.

Also, compute values for  $VC_2$ ,  $V_{tune}$ , for the case when enough cycles expire and the circuit is in its steady state.



**Problem 2:**

Consider the Gm-C integrator shown in the figure below.

Explain what the function of Q3,4 is in this circuit.

Why are the amplifiers preceding Q3,4 added?

Assume the two gm boosting amplifiers have high gain and that Q1 & Q2 operate in triode mode,  $\mu C_{ox}=100\mu A/V^2$ , and W/L of Q1 & Q2 is 10,  $V_{th}=0.5V$  and  $V_{CM}=1V$ .

Consider two cases:

1.  $V_c=0.2V$
2.  $V_c=0.4V$

For both cases:

- a- Find the transconductance for this circuit.
- b- Find the unity gain frequency of the integrator for  $C_{intg}=10pF$
- c- Find the current flowing in Q1 & Q2 for both  $V_c$  values for  $V_i=0$
- d- Find the maximum input voltage swing before either of the transistors exits the triode region.

Assume the regular long channel transistor models.

