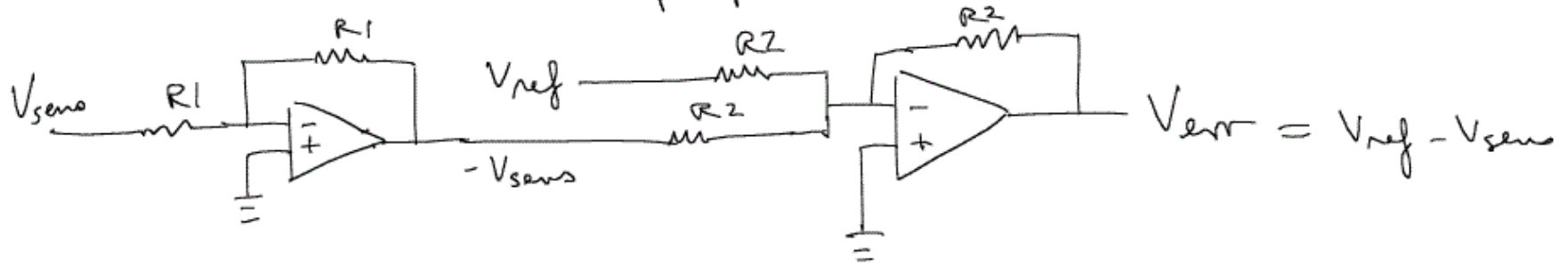


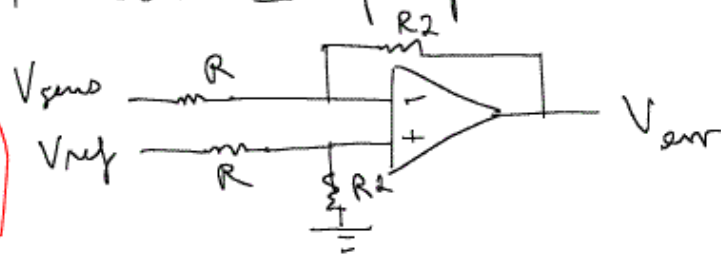
a. Calculate V_{err} from V_{ref} and V_{sens}

Solution 1: Use 2 op-amps. With the first opamp, construct an inverting amplifier with a gain of one. With the second opamp, construct a summer.



Solution 2: Use 1 opamp to construct a difference amplifier

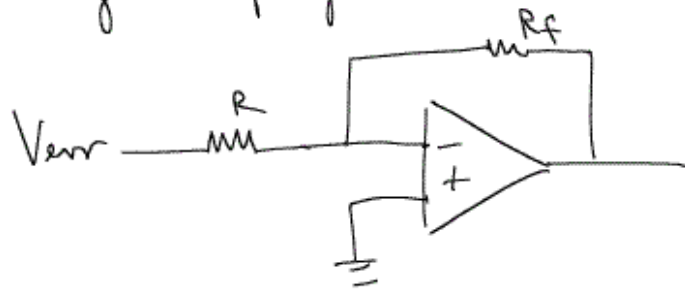
See problem 2 for further analysis



$$V_{err} = \frac{R_2}{R} (V_{ref} - V_{sens})$$

Choose $R_2 = R$

b) Take in V_{in} and output $-10 V_{in}$
 Inverting amplifier with $10 \times$ gain:

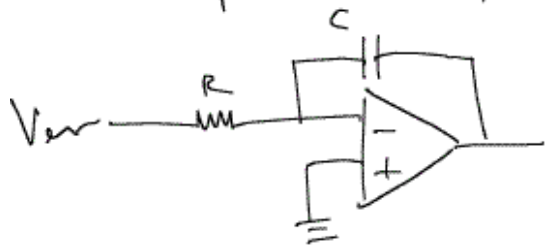


$$V_{out} = -\frac{R_f}{R} V_{in}$$

Choose

$$R_f = 10R$$

c) Input V_{in} , output $V_{out} = -2 \int V_{in} dt$



$$V_{out} = V_{out} = -\frac{1}{RC} \int_0^T V_{in} dt + k$$

Discussed in class

output voltage
at $t=0$

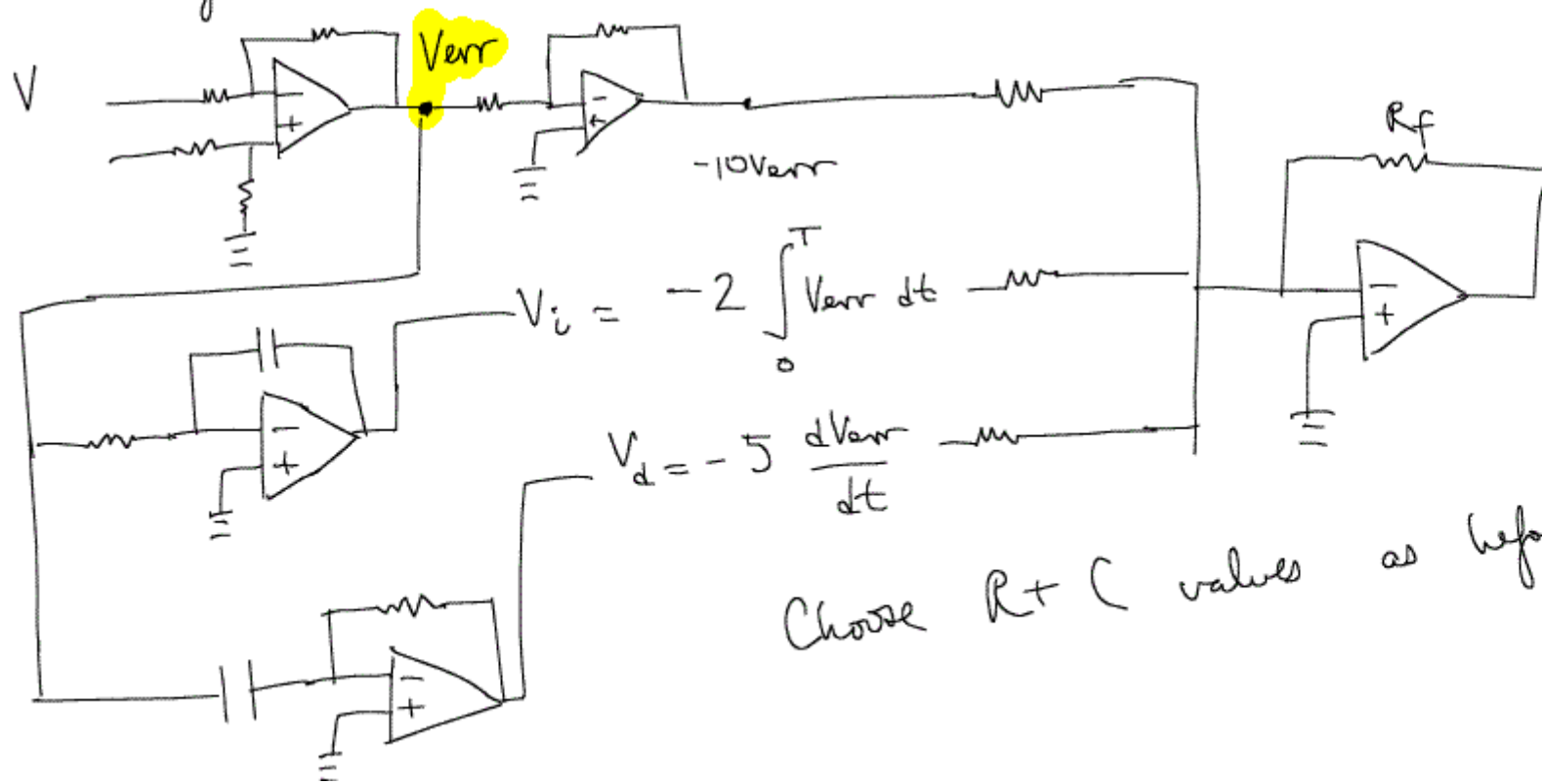
$$\text{Choose } RC = 0.5 \text{ sec}$$

d) Input V_{err} , output $V_o = -5 \frac{dV_{err}}{dt}$



Choose
 $RC = 5 \mu s$

e) All together now! Build a Summer



Choose $R + C$ values as before.