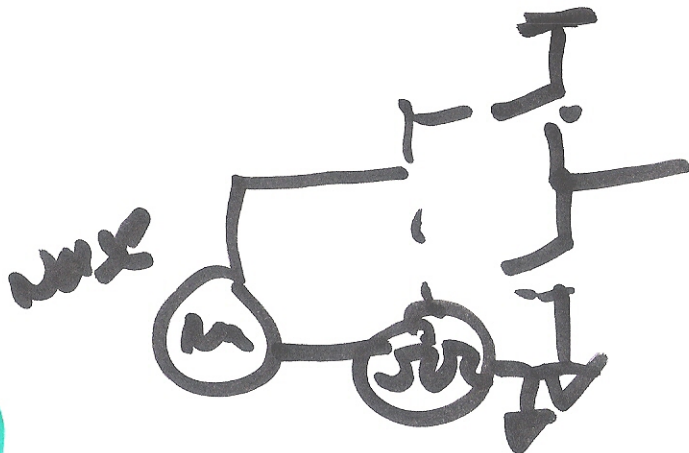
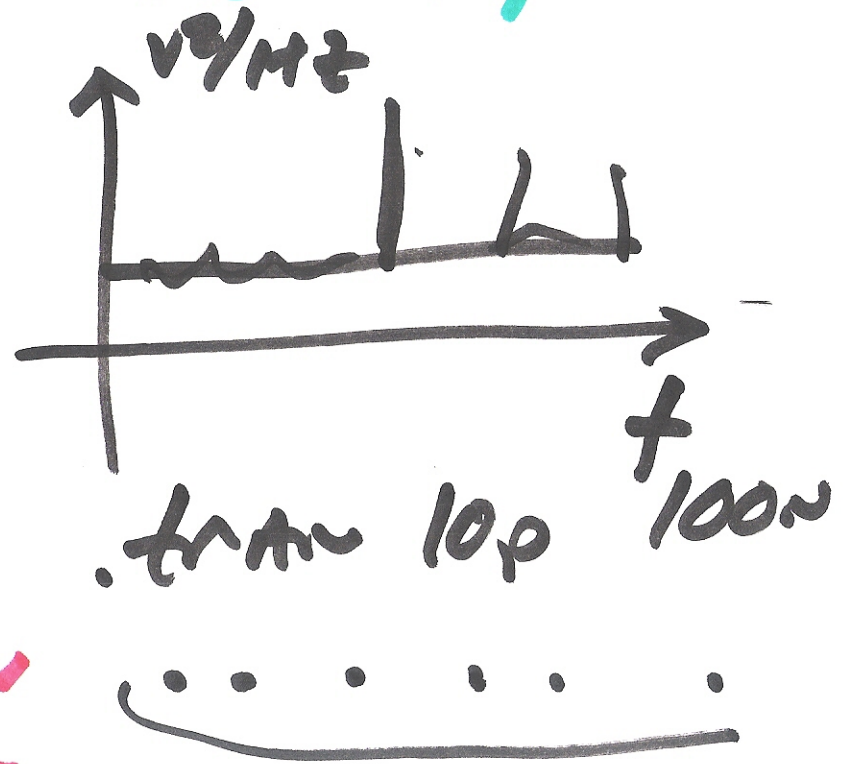
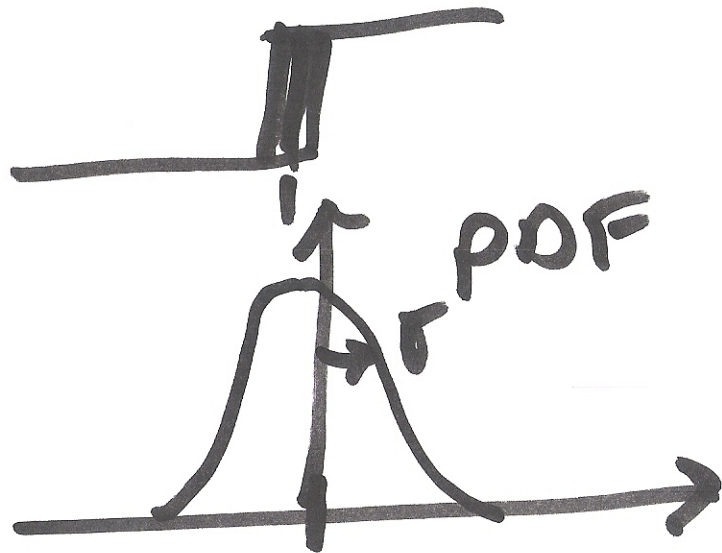


ECE 615 CMOS mixed-signal CIRCUIT DESIGN

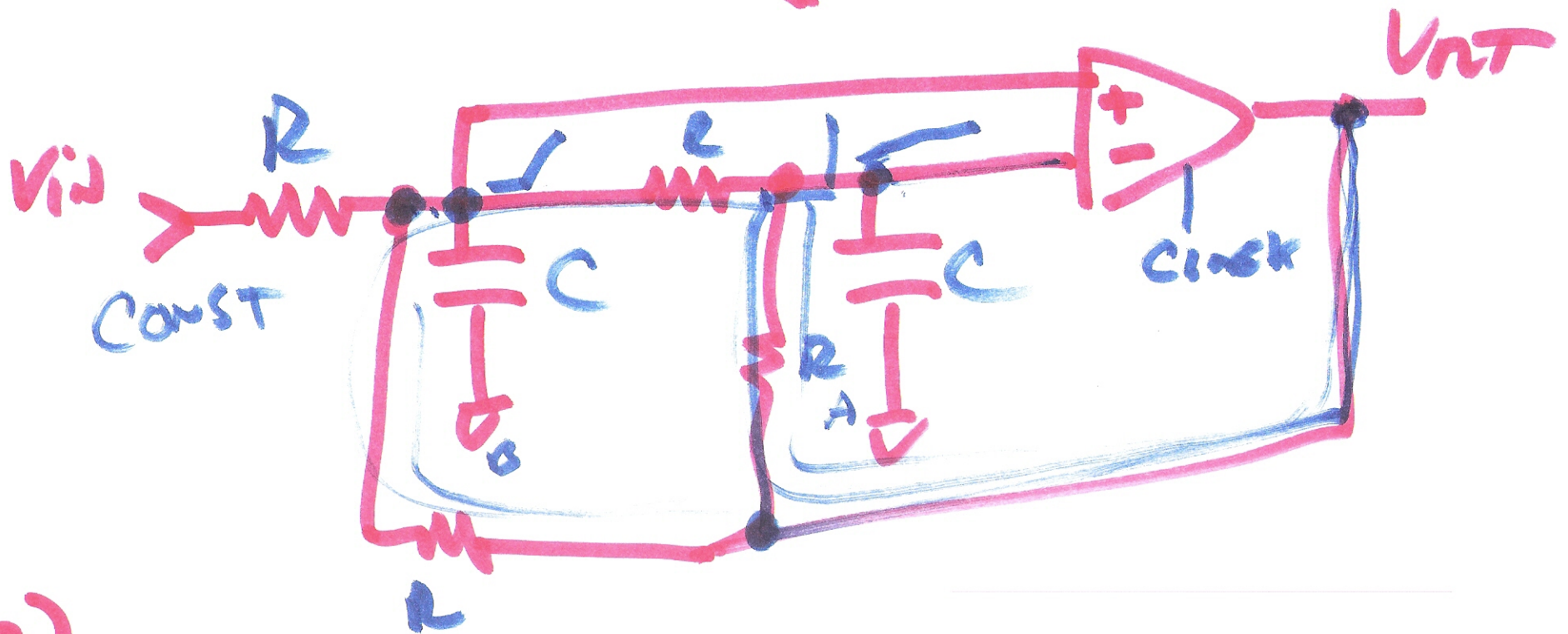
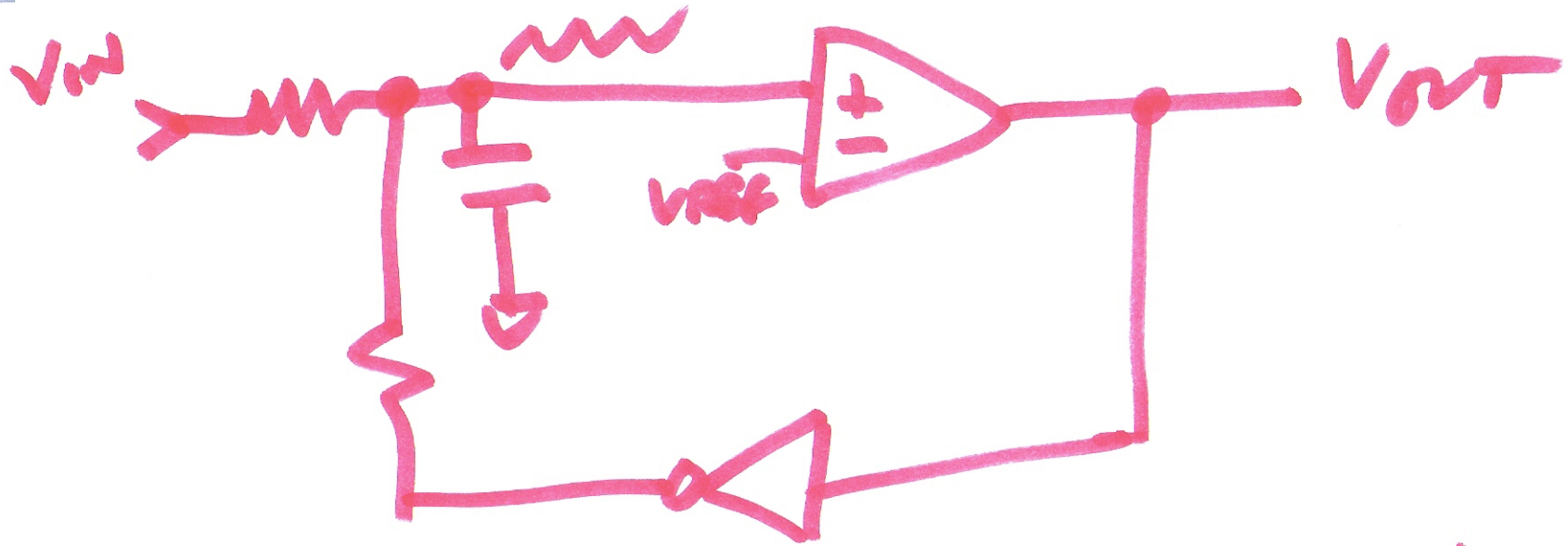
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Lecture 20

NOV. 1, 2010



Passive Modulators

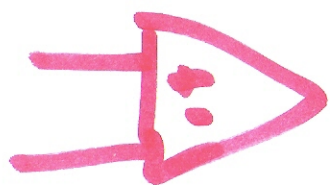


2)

$$(v_{in1}^2 + v_{in2}^2) \left((w_{ec})^2 + (-1)^2 \right) =$$

$$\left(1 + (w_{ec})^2 \right) (v_{out,noise}^2 + v_{out,signal}^2)$$

$$v_{out1}^2 + v_{out2}^2 = (w_{ec})^2 \cdot \frac{v_{in}^2}{2}$$



$$v_{out,noise}^2 = \frac{(w_{ec})^2 \cdot v_{in}^2}{1 + (w_{ec})^2} \cdot \frac{v_{in}^2}{2}$$

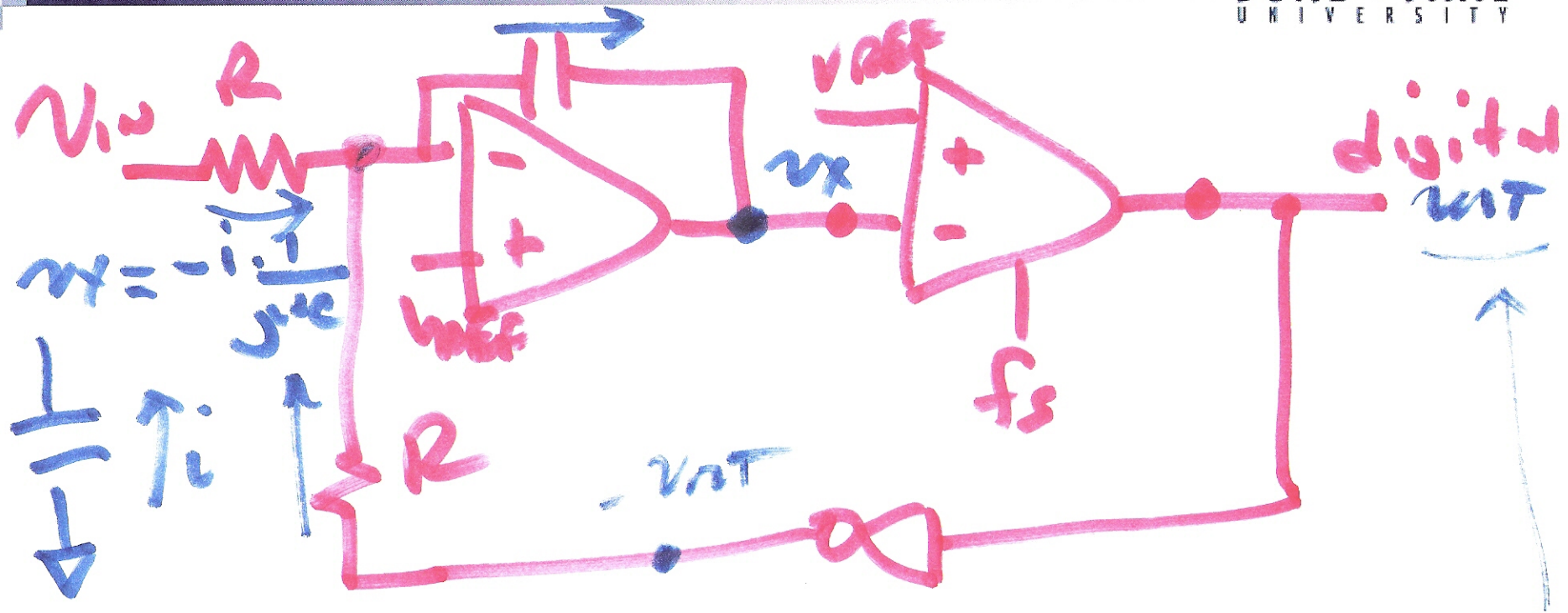


$$v_{out,signal}^2 = \frac{1}{1 + (w_{ec})^2} \cdot v_{in}^2$$

$$v_{out,noise} = \frac{v_{in} \cdot w_{ec}}{\sqrt{2}}$$

3)

Using an Active Integrator



$$\left(\frac{V_{in}}{R} + \frac{-v_{DT}}{R} \right) \left(1 + \frac{1}{j\omega C} \right) + V_{REF} = v_{DT}$$

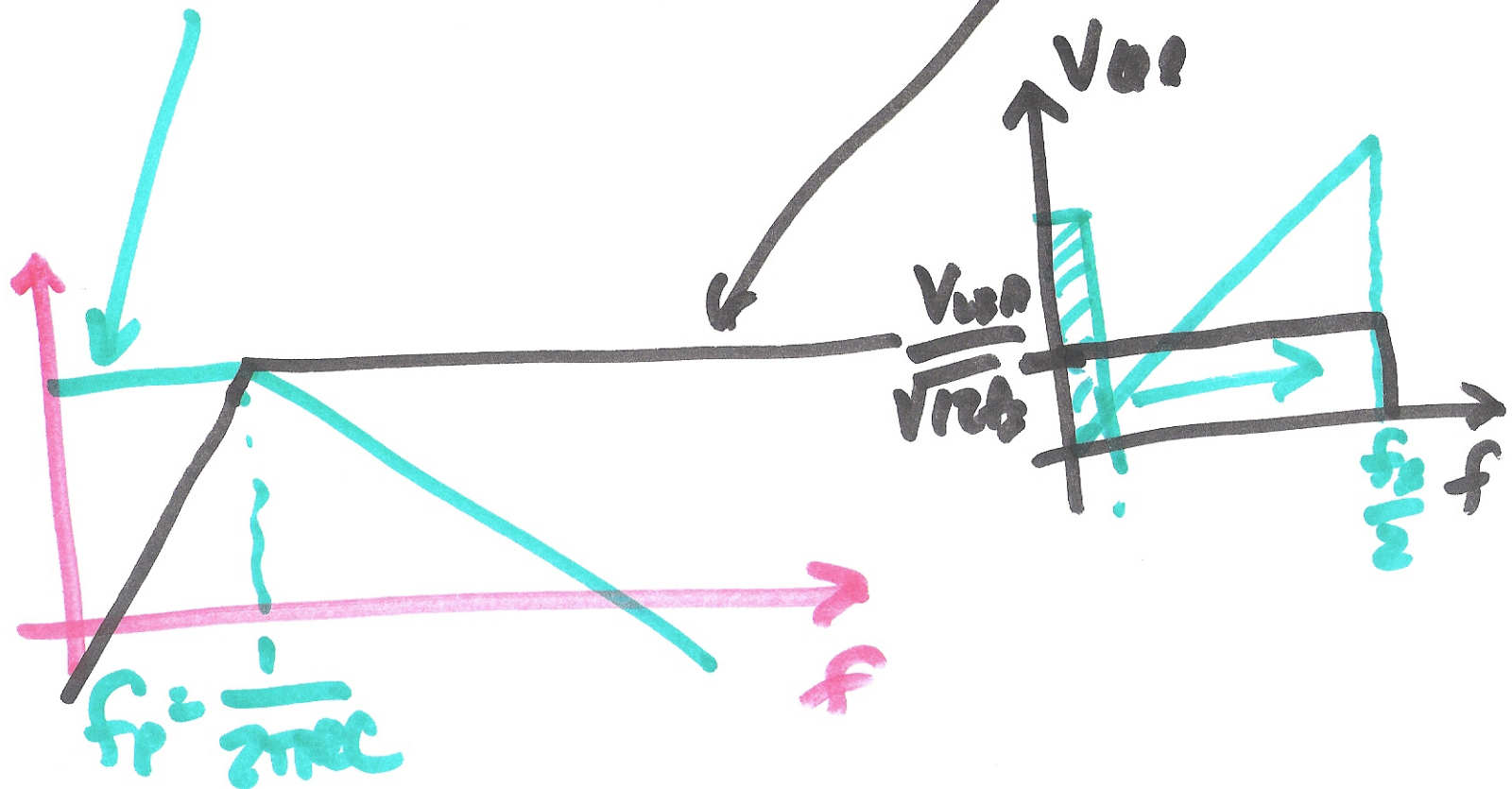
$$v_{DT} \left(1 + \frac{1}{j\omega C} \right) = \frac{v_{in}}{j\omega C} + V_{REF}$$

4)

$$V_{out} = \frac{V_{in}}{j\omega RC + 1} + \frac{V_{oc} \cdot j\omega RC}{1 + j\omega RC}$$

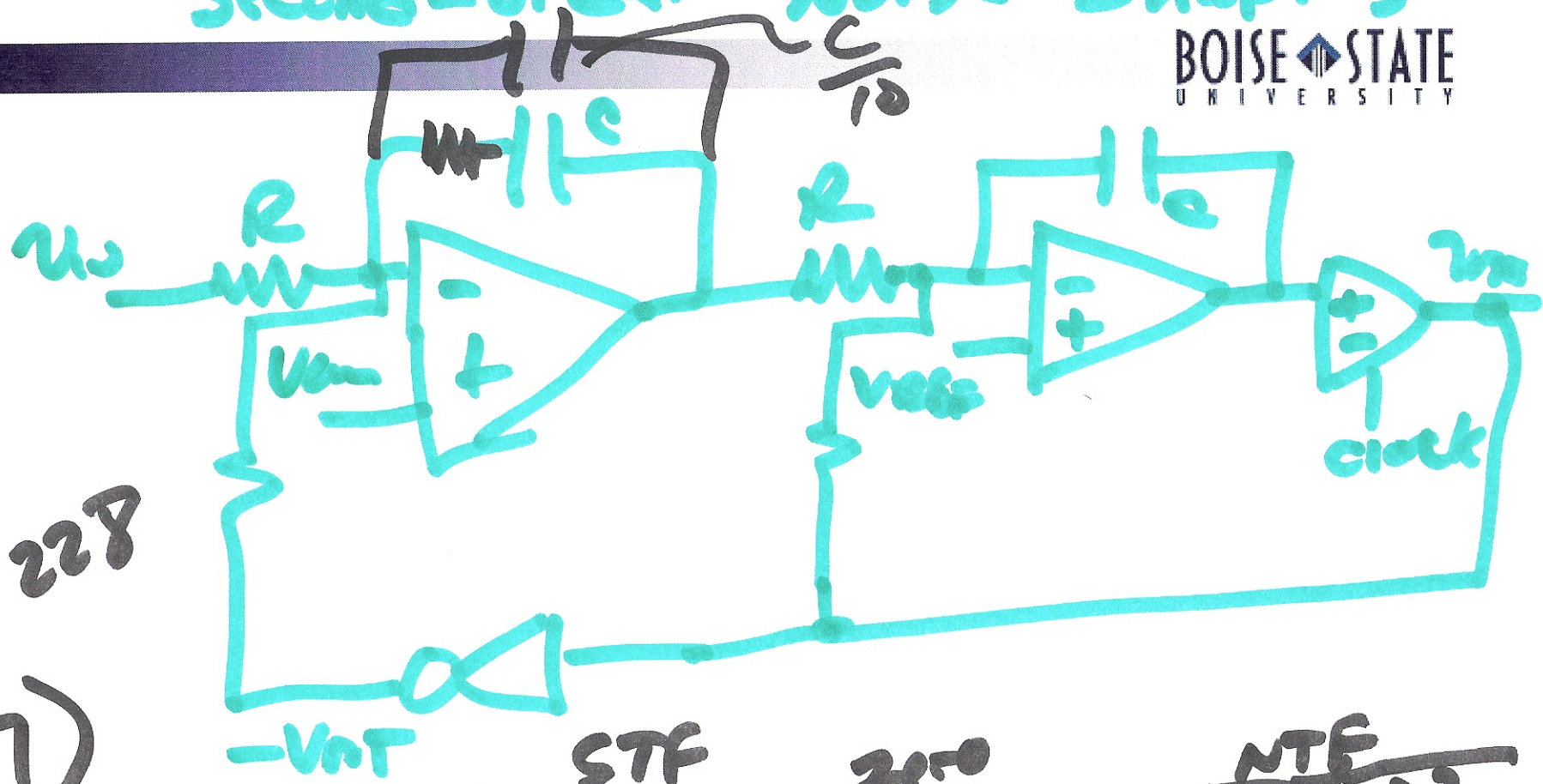
$$STF = \frac{1}{1 + j\omega RC}$$

$$NTF = \frac{j\omega RC}{1 + j\omega RC}$$



5)

Second-order Noise-Shaping



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(6.67)

$$V_{NT} = \frac{1}{RC} \frac{1}{(j\omega RC)^2 + j\frac{\omega RC}{RC} + \frac{1}{RC^2}} \cdot u_d + \frac{\frac{NTE}{(j\omega RC)^2}}{(j\omega RC)^2 + j\omega RC + 1} V_{eq}$$

$$s^2 + \frac{s}{RC} + \frac{1}{RC^2}$$

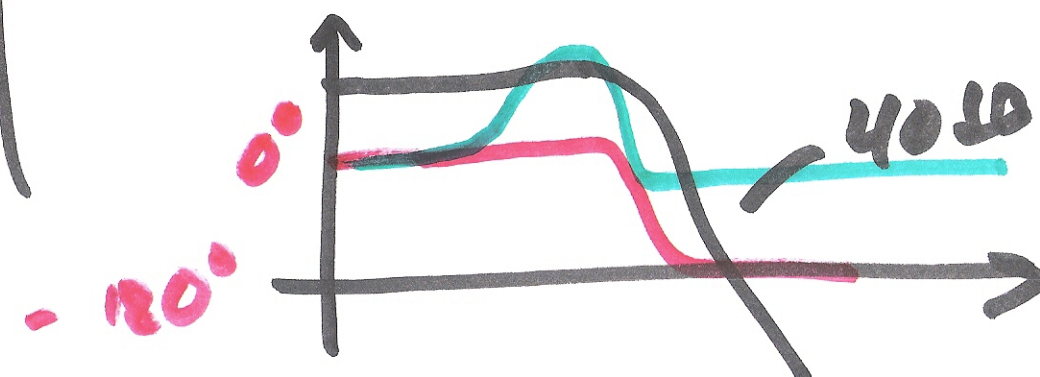
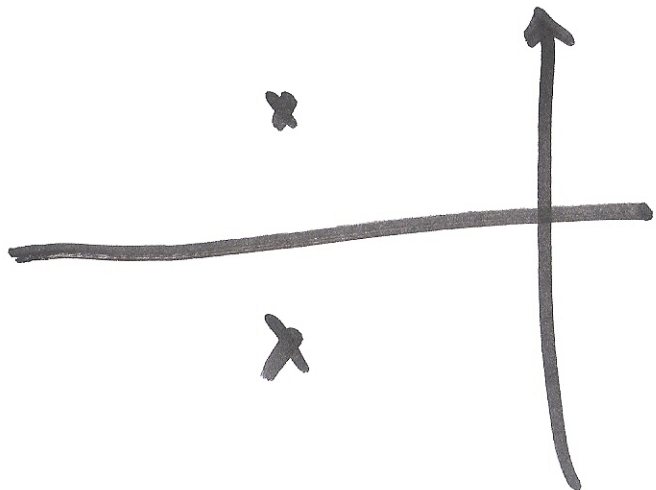
$$\omega \rightarrow -j\omega$$

6)

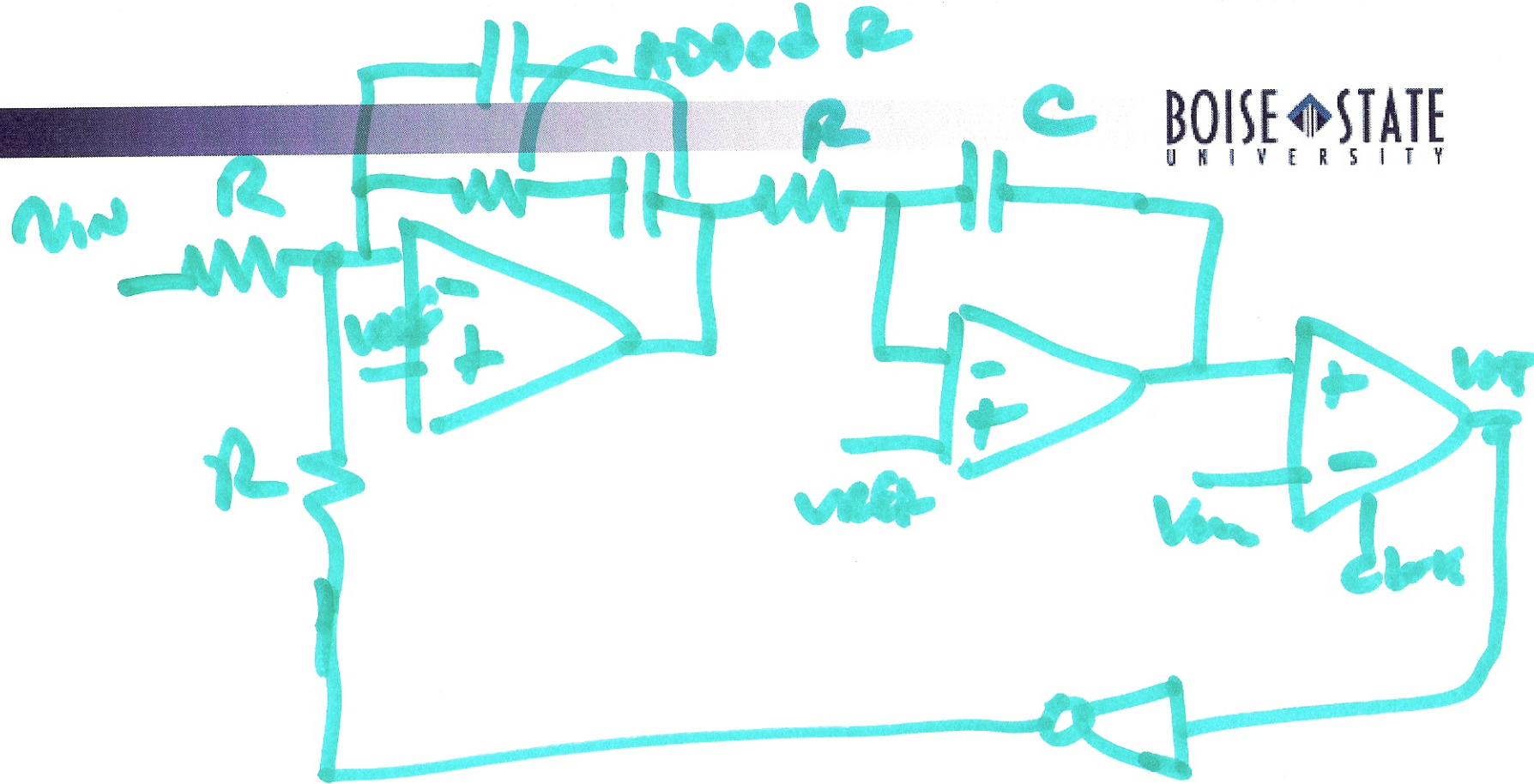
$$\frac{(1/RC)^2}{s^2 + \frac{s}{RC} + \left(\frac{1}{RC}\right)^2}$$

$$P_1, P_2 = \frac{-\frac{1}{RC} \pm \sqrt{\left(\frac{1}{RC}\right)^2 - \frac{4}{(RC)^4}}}{2}$$

$$= -\frac{1}{2RC} \pm i \cdot \frac{1}{2RC} \cdot \sqrt{3}$$

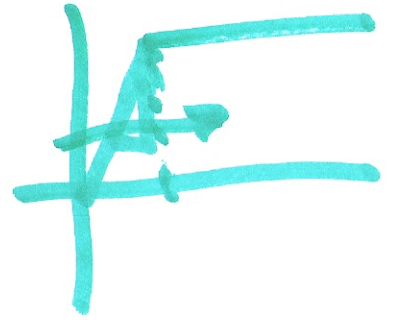


7)

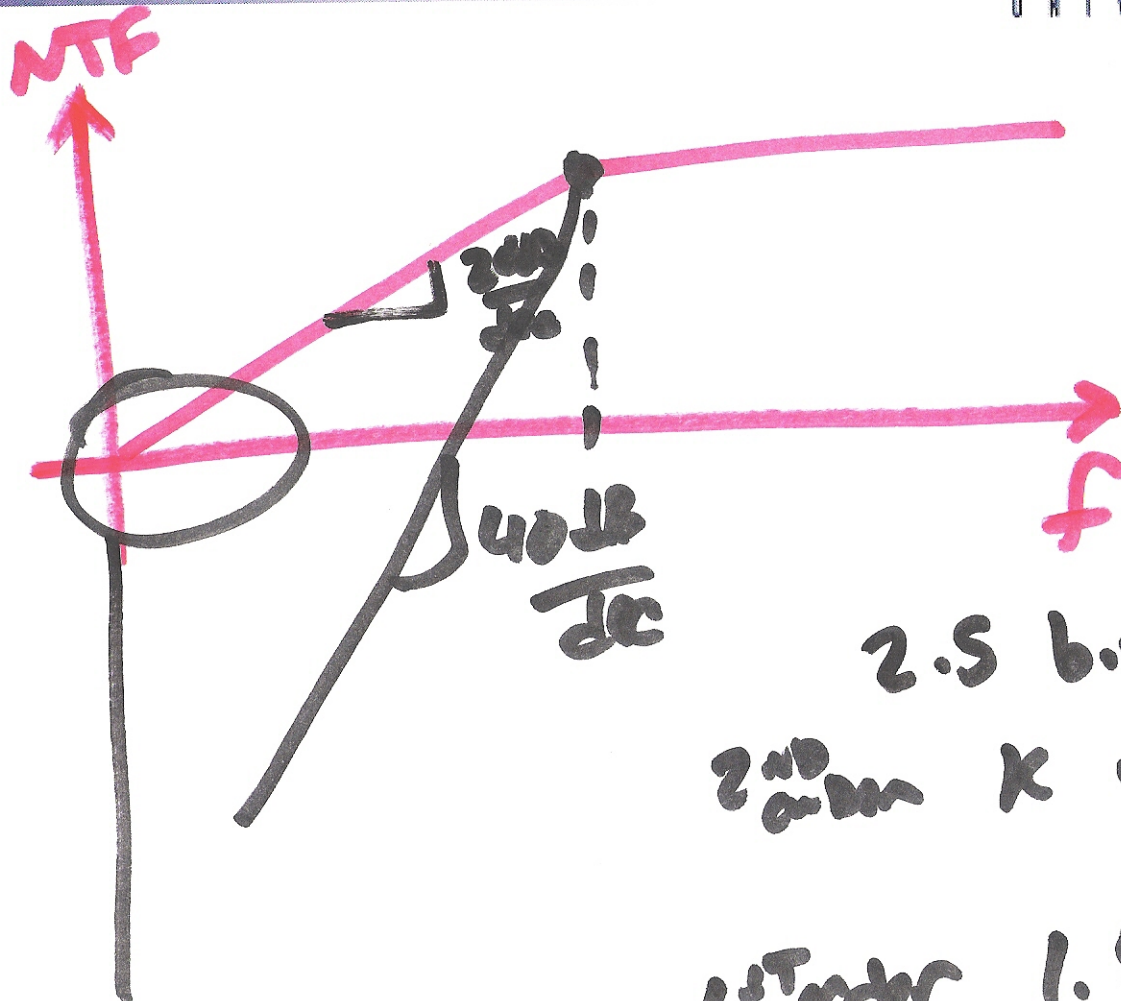


$$STF = \frac{1 + sRC}{s^2(RC)^2 + sRC + 1}$$

$$NTF = \frac{s^2 RC^2}{s^2(RC)^2 + sRC + 1}$$

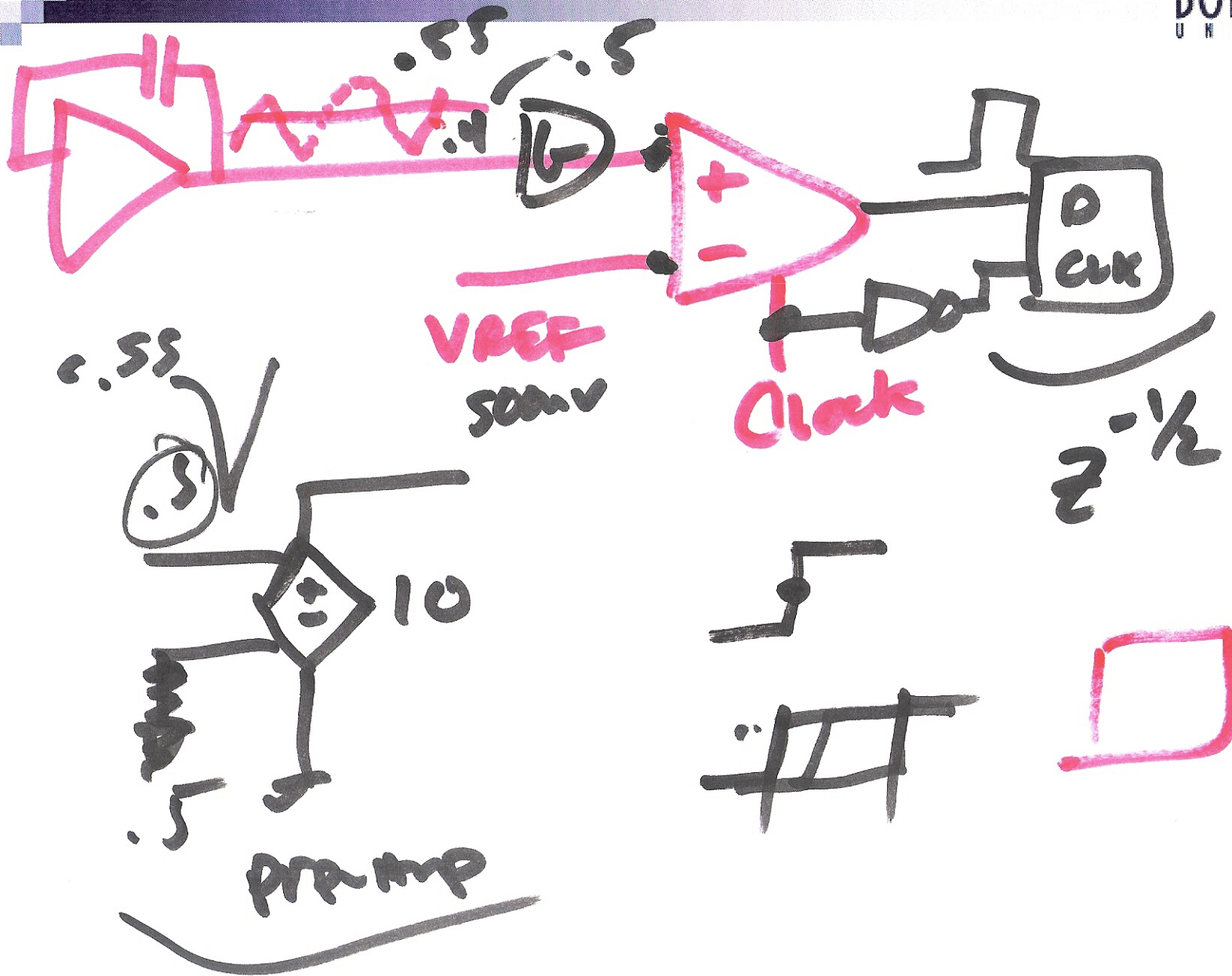


8)



2.5 bits \nearrow
 2nd order κ doubling
 1st order 1.5 bits κ -doubling
 Simple averaging 0.5 bits

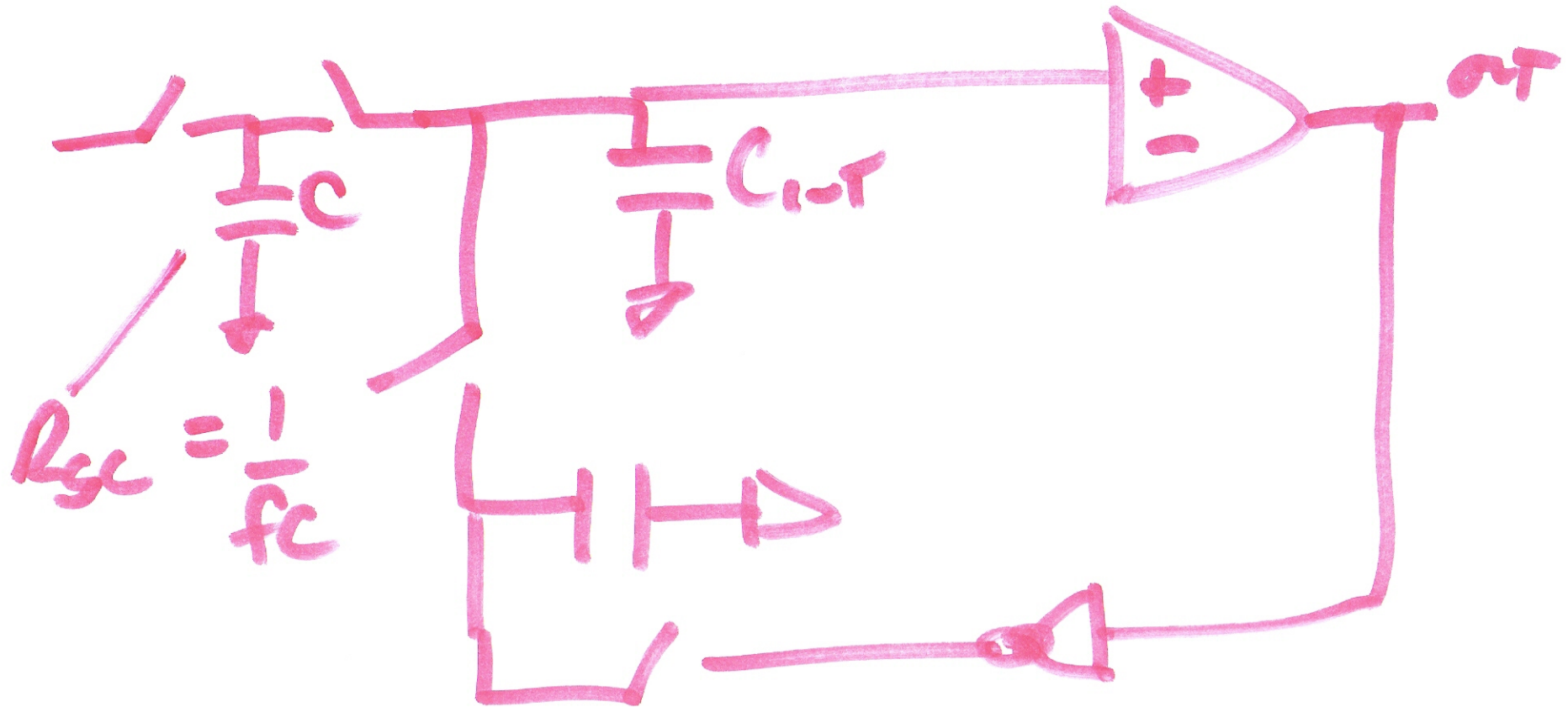
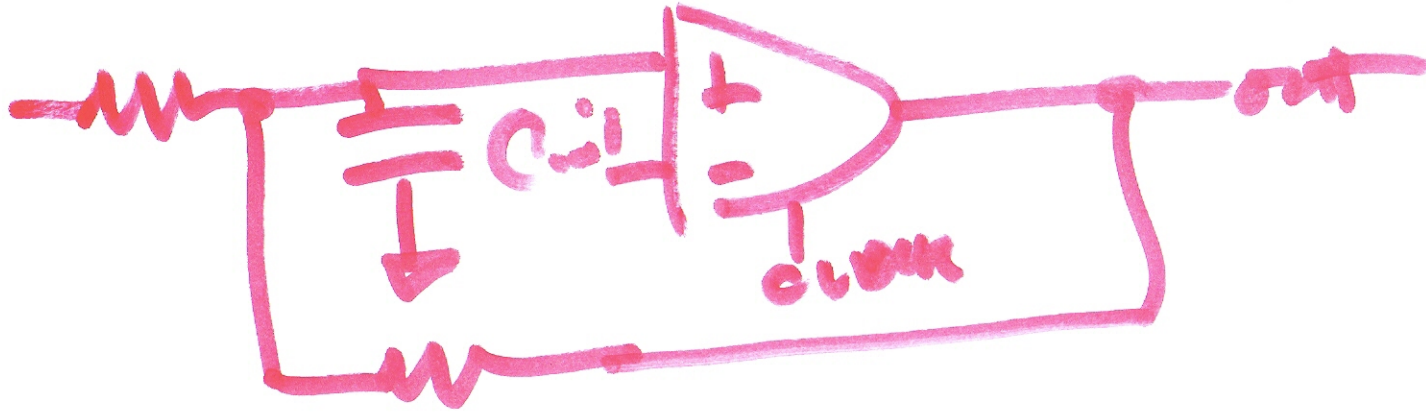
1)



10)

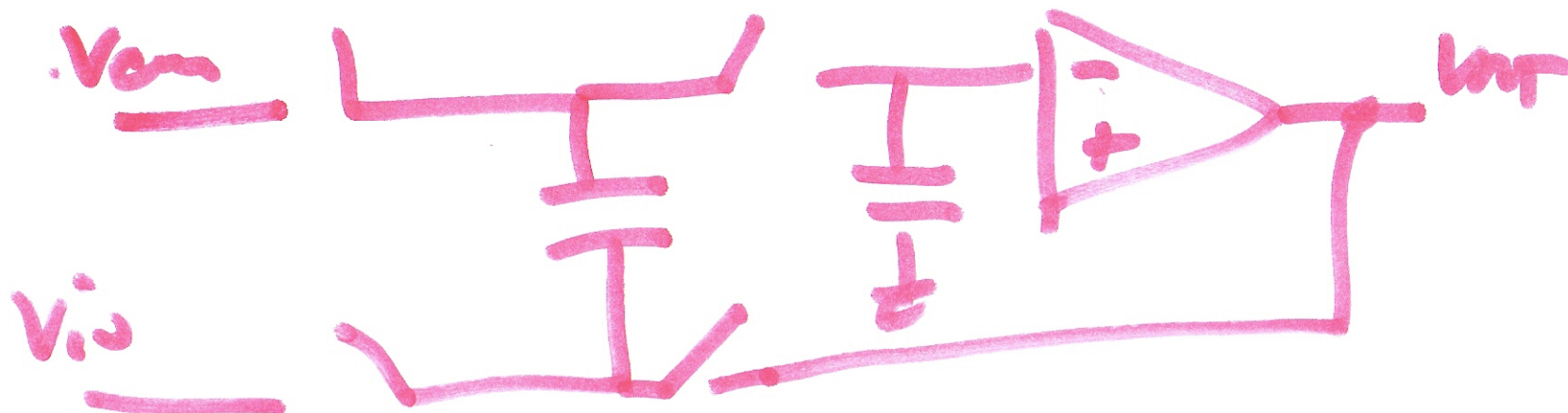
Switched - Capacitor

NS mod.



ii)

Fig. 6.22



NO gain error

12)