IPLE ≡ HARDWARE OF COMPUTERS

AGAIN LABORATORIES

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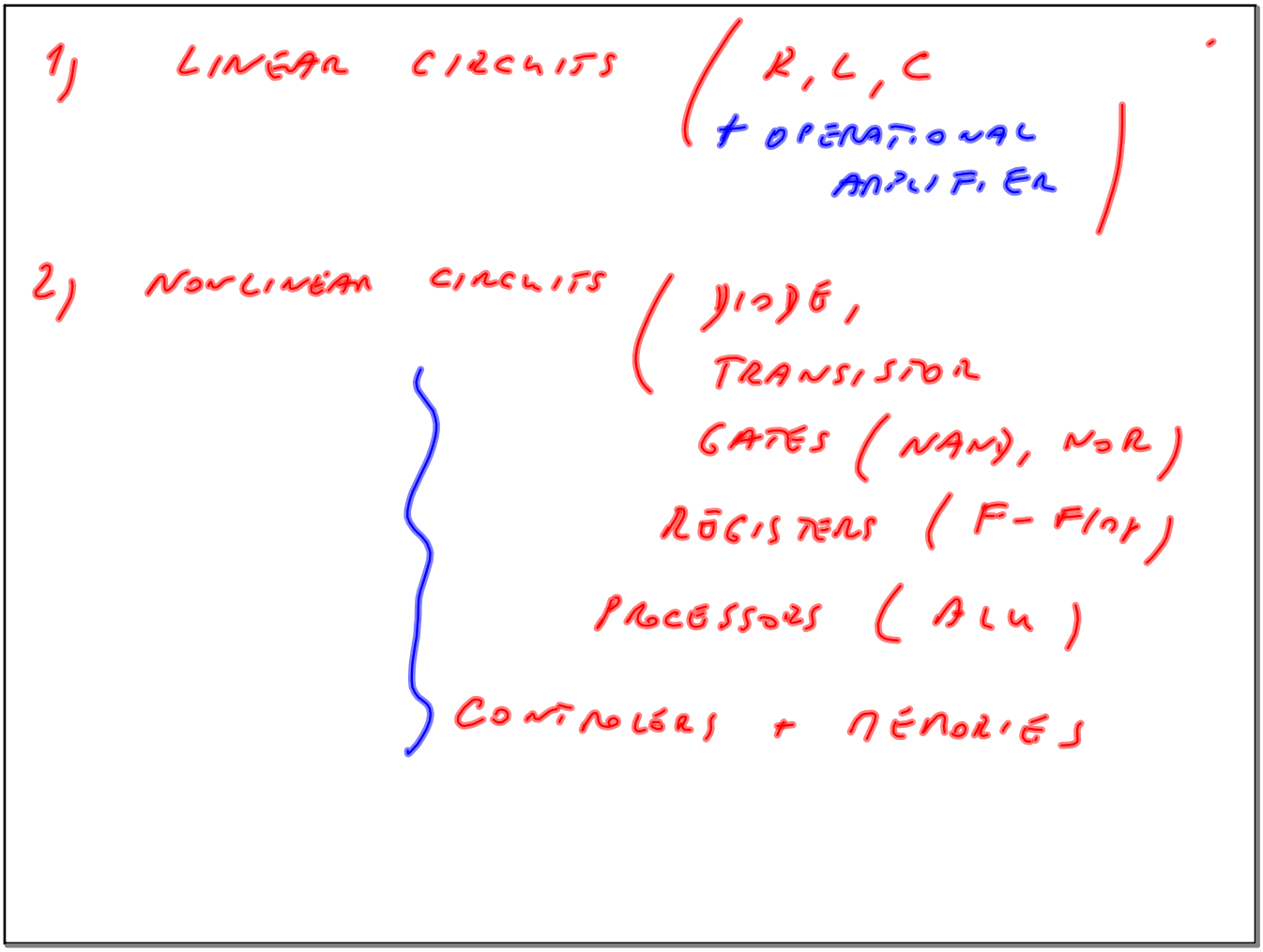
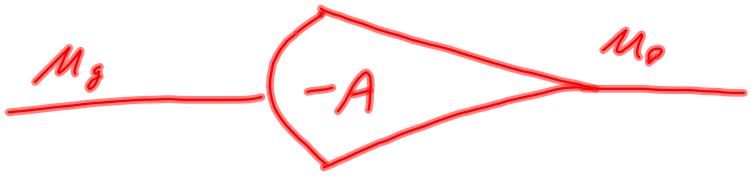

1) LINEAR CIRCUITS
R, L, C
+ OPERATIONAL AMPLIFIER
2) NONLINEAR CIRCUITS
DIODE,
TRANSISTOR
GATES (NAND, NOR)
REGISTERS (F-FLIP)
PROCESSORS (ALU)
CONTROLERS + MEMORIES

OPERATIONAL AMPLIFIER

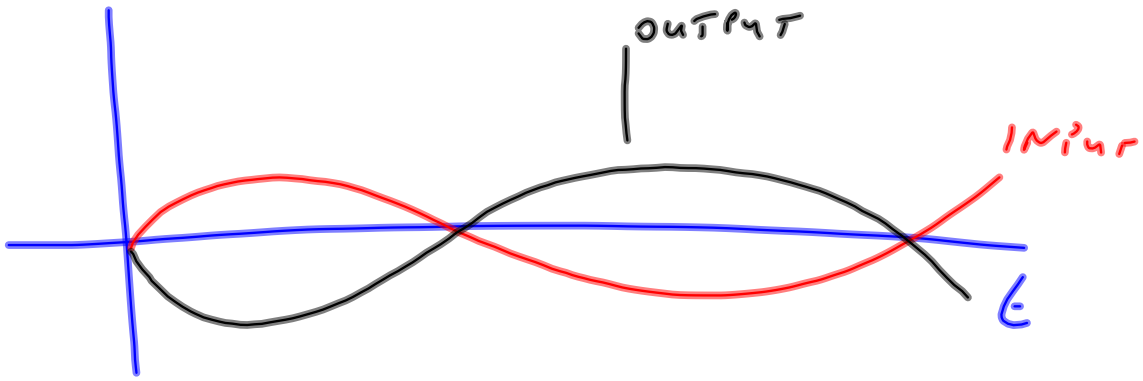


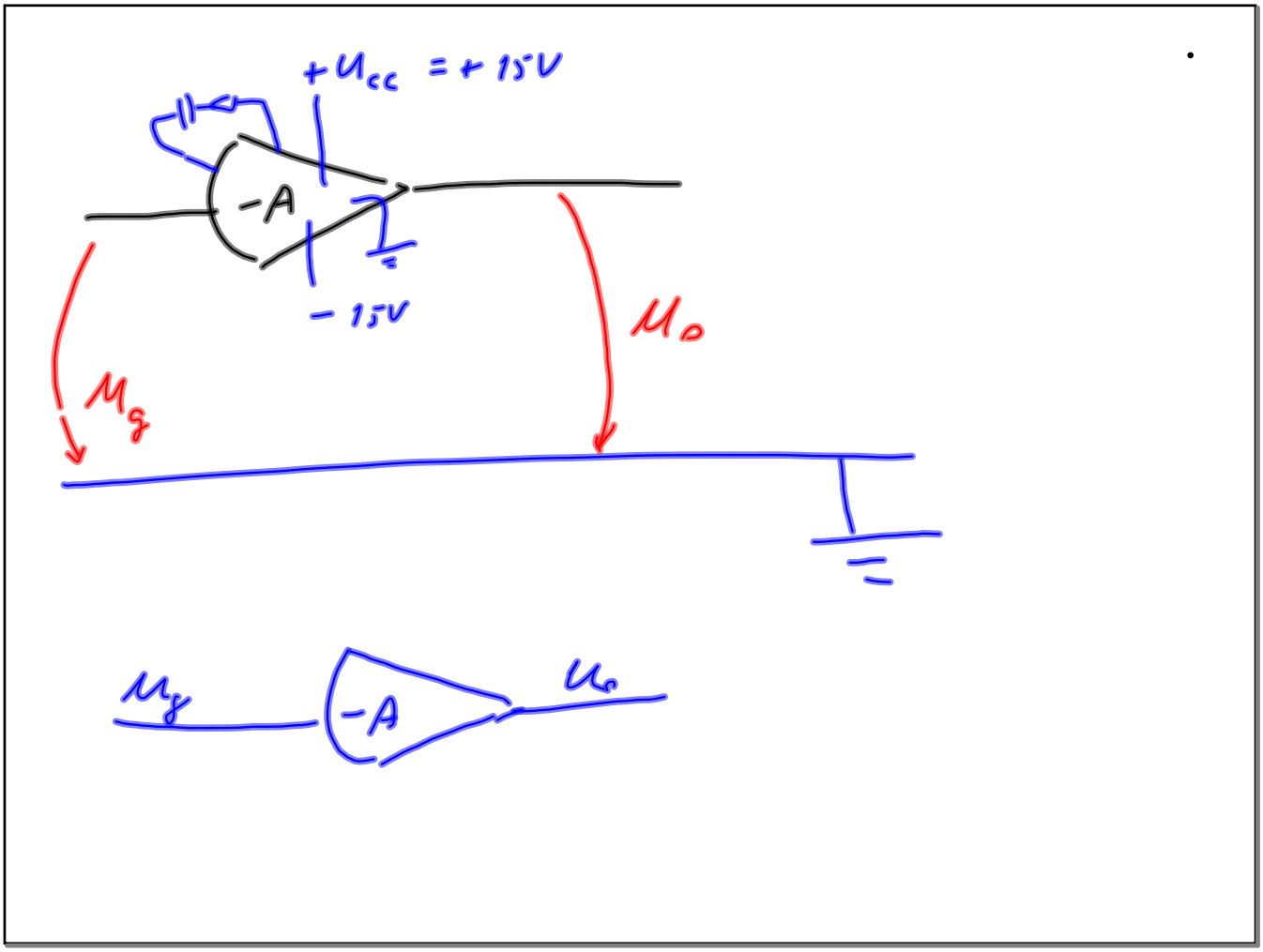
u_g ... INPUT VOLTAGE

u_0 ... OUTPUT VOLTAGE

A .. GAIN

- (minus) ≡ INVERSE OF VOLTAGE




+Ucc = +15V
-A
-15V
Uo
Ug
Ug
-A
Uo

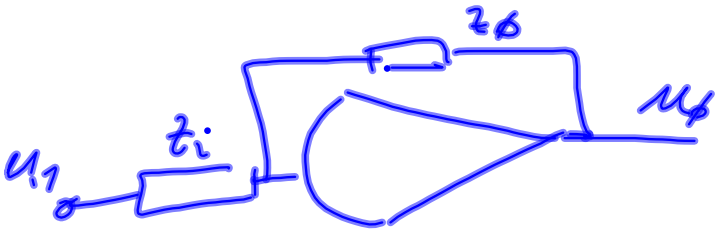
PROPERTIES OF OA

1) $A \rightarrow \infty$

2) R_{IN} (input resistance) $\rightarrow \infty \Omega$

3) R_{out} (output resistance) $\rightarrow 0 \Omega$

PRACTICAL EXAMPLES



z_0 ... FEEDBACK IMPEDANCE

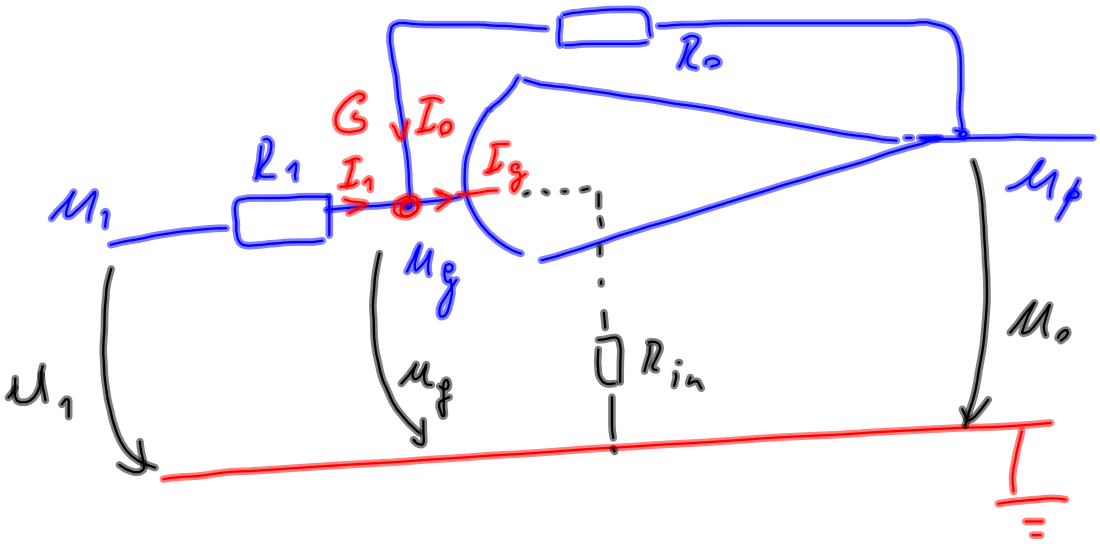
z_i ... INPUT IMPEDANCE

$$u_0 = f(u_i)$$

???

$z_g = R_g$ – rezistor

$z_1 = R_1$ . . –"–



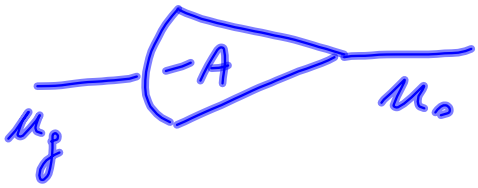
$$I_1 + I_0 = I_g$$

$$I_1 = \frac{U_1 - U_g}{R_1}$$

$$I_0 = \frac{U_0 - U_g}{R_0}$$

$$I_g = \frac{U_g}{R_{in}}$$

$$\frac{u_1 - u_g}{R_1} + \frac{u_o - u_g}{R_2} = \frac{u_g}{R_{in}}$$



$$u_o = -A \cdot u_g$$

$$u_g = \frac{u_o}{-A}$$

$A \to \infty$

$$\boxed{u_g = 0}$$

$$\frac{u_1}{R_1} + \frac{u_0}{R_0} = 0$$

$$u_0 = f(u_1)$$

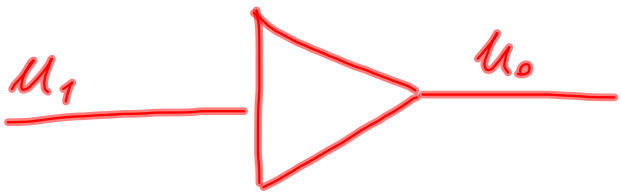
$$u_0 = -u_1 \frac{R_0}{R_1}$$

VERY OFTEN $R_0 = R_1 = R$

$$u_0 = -u_1 \cdot \frac{R_0}{R_1}$$

INVERSE OF SIGN

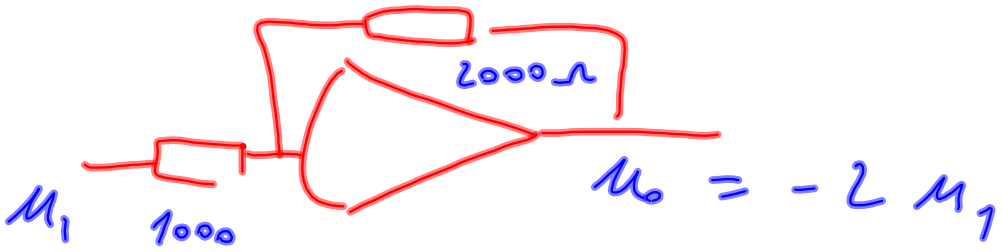
SYMBOL FOR INVERTOR.



$u_0 = -u_1$

$u_0 = -2\,u_1$?!

$\frac{R_0}{R_1} = 2$



How to solve

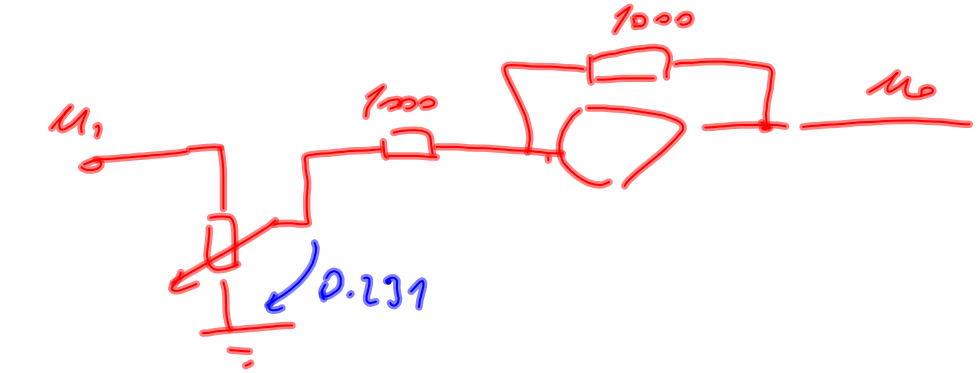
$$U_0 = -0.231\, U_1$$

$$\frac{R_0}{R_1}$$

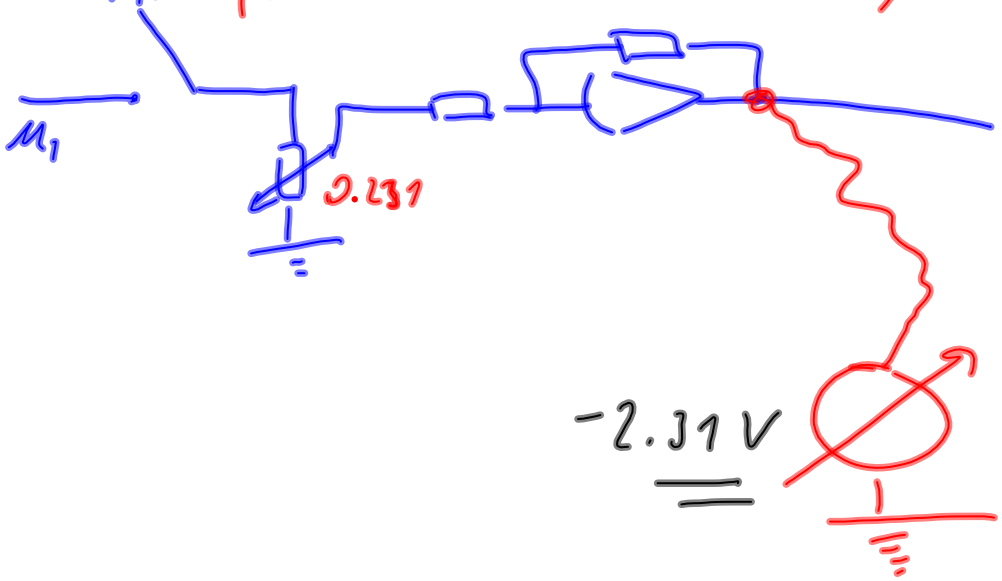
$R_1 = 1000\ \Omega$

$R_0 = 231\ \Omega$

Using potentiometer



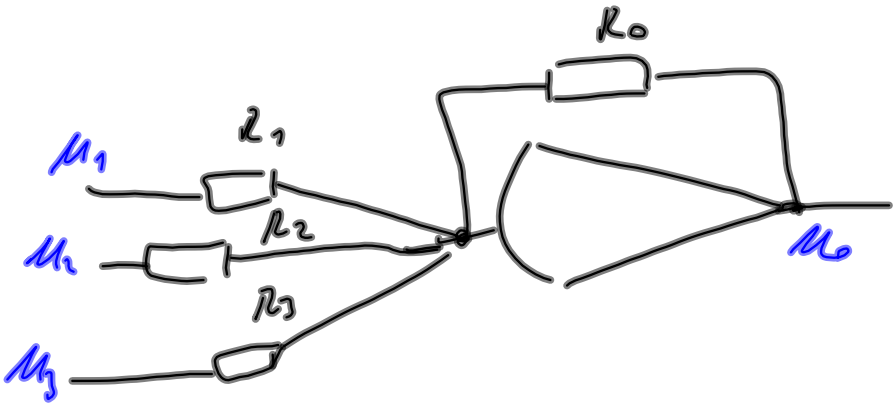
+10V (special voltage source)



Also voltage source −10 V

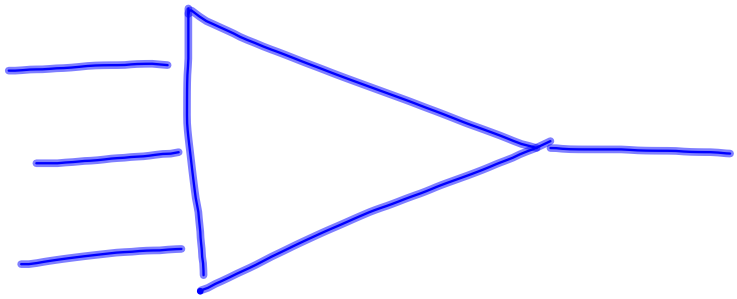
2 13-11:16

SUMMER

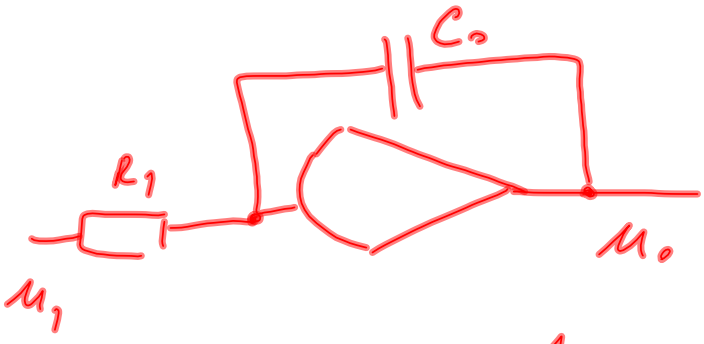


$$u_0 = -u_1 \frac{R_0}{R_1} - u_2 \frac{R_0}{R_2} - u_3 \frac{R_0}{R_3}$$

TYPICALLY $R_0 = R_1 = R_2 = R_3$



ALL EXAMPLES WERE NOT TIME DEPENDENT



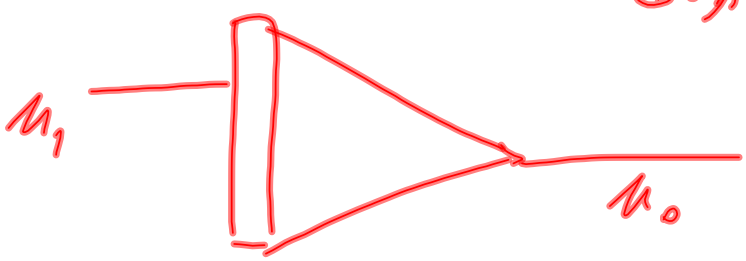
$$u_0(t) = -\frac{1}{R_1 C_0}\int u_1(t)\,dt + u_0(0)$$

AGAIN

$$\frac{1}{R_1 C_0} = 1$$ GAIN

$$u_0(t) = -\int u_1(t)\,dt + u_0(0)$$

INITIAL CONDITION

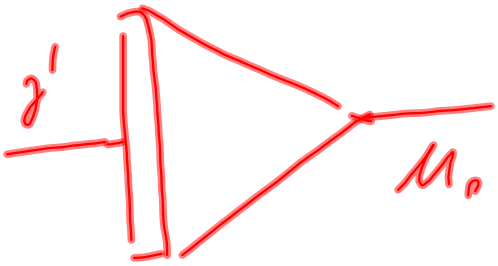


$$u_0 = -\int u_1\,dt + u_0$$

2 13-11:16

$y' = y \qquad y(0) = 1$

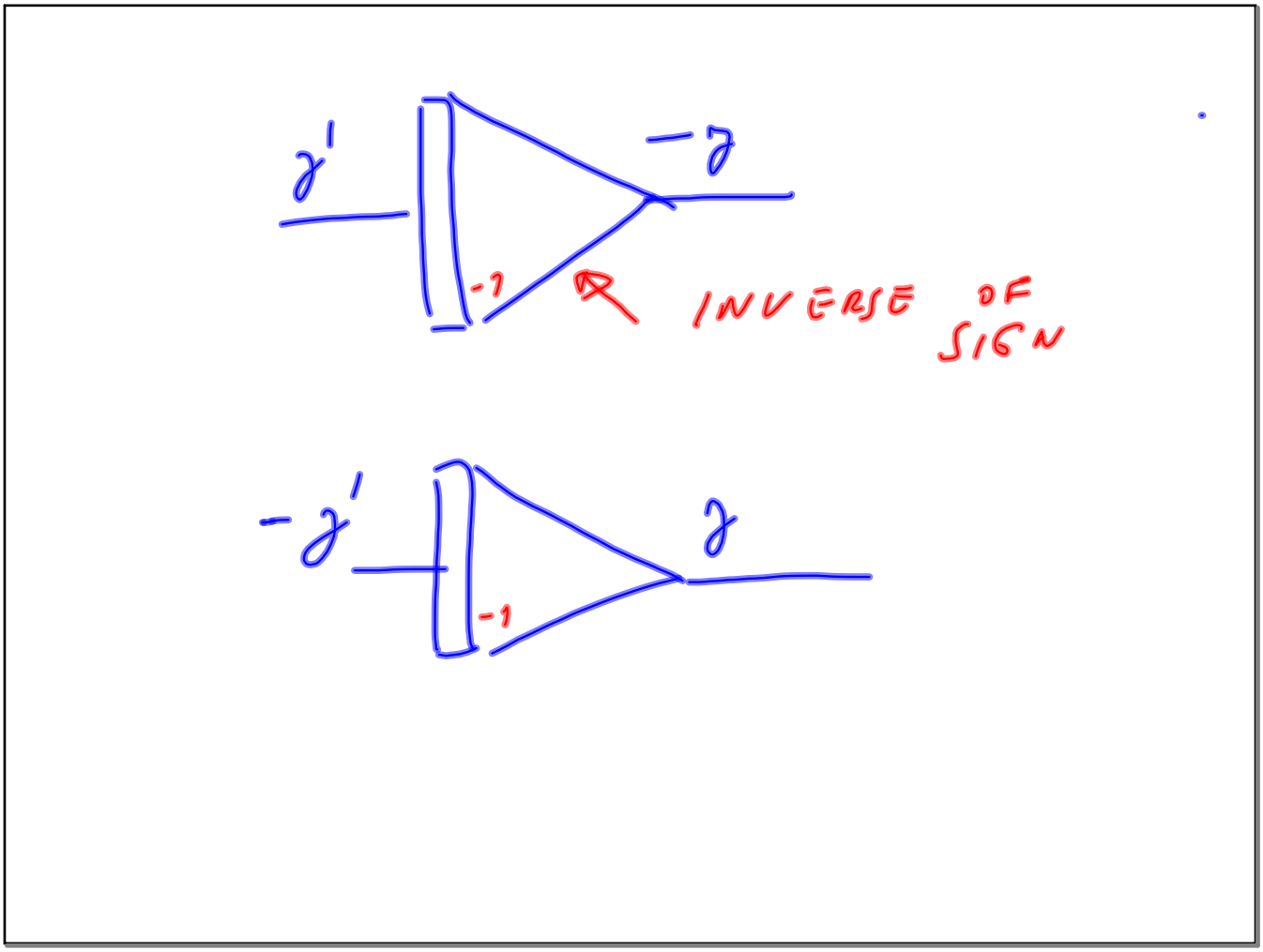
$u_0 = 0$

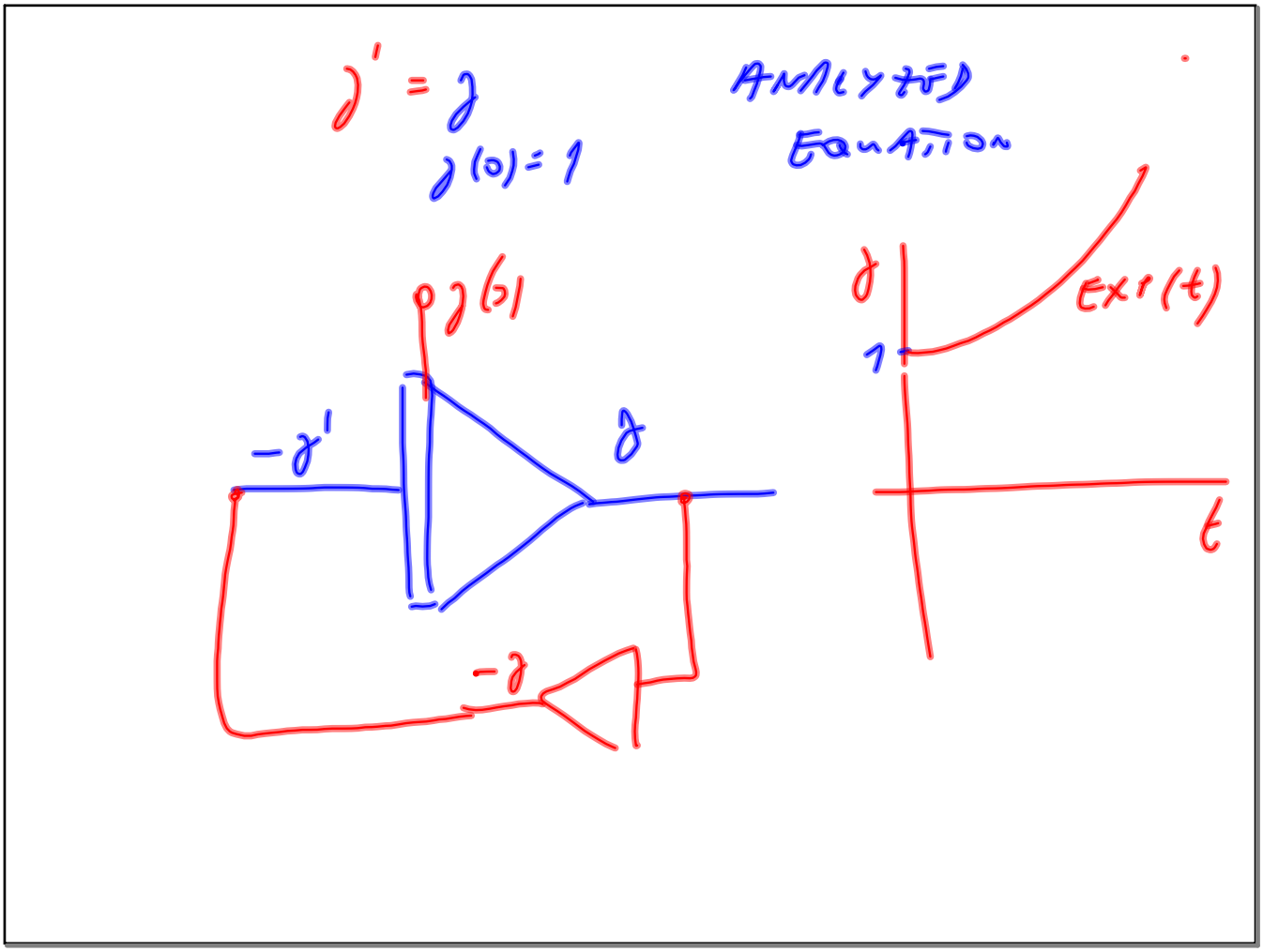


$$u_0 = -\int y'\,dt$$

$$u_0 = -\int \frac{dy}{dt}\,dt$$

$$u_0 = -y$$


y'
-y
-1
INVERSE OF SIGN
-y'
y
-1


y' = y
y(0) = 1
ANALYTED
EQUATION
y(0)
-y'
y
-y
y
1
Exp(t)
t

GENERATION OF FUNCTION

$y = \sin t$

$y' = \cos t$

$v = \cos t$

$v' = -\sin t$

$$\begin{cases} y' = v & y(0) = 0 \\ v' = -y & v(0) = 1 \end{cases}$$