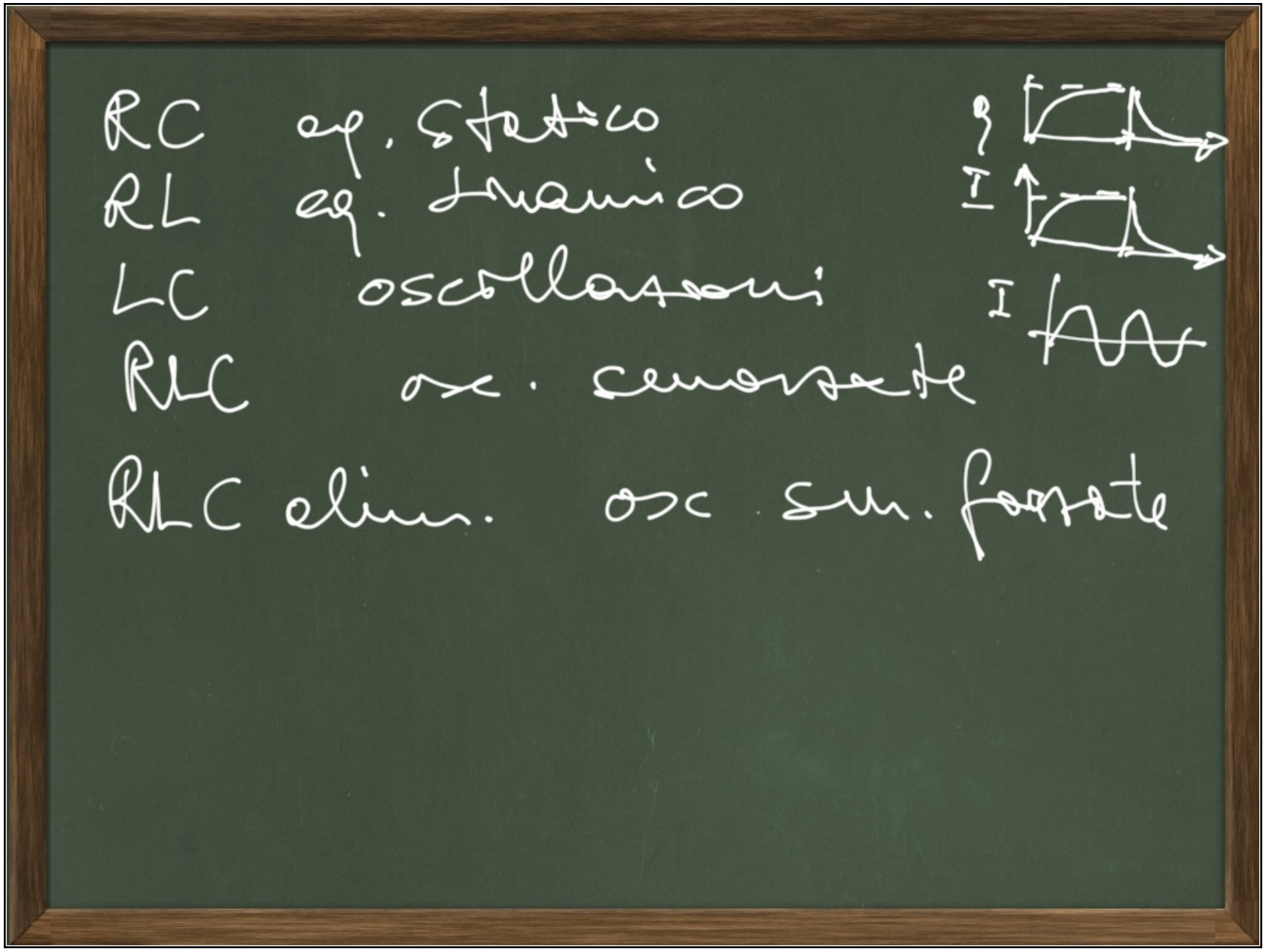
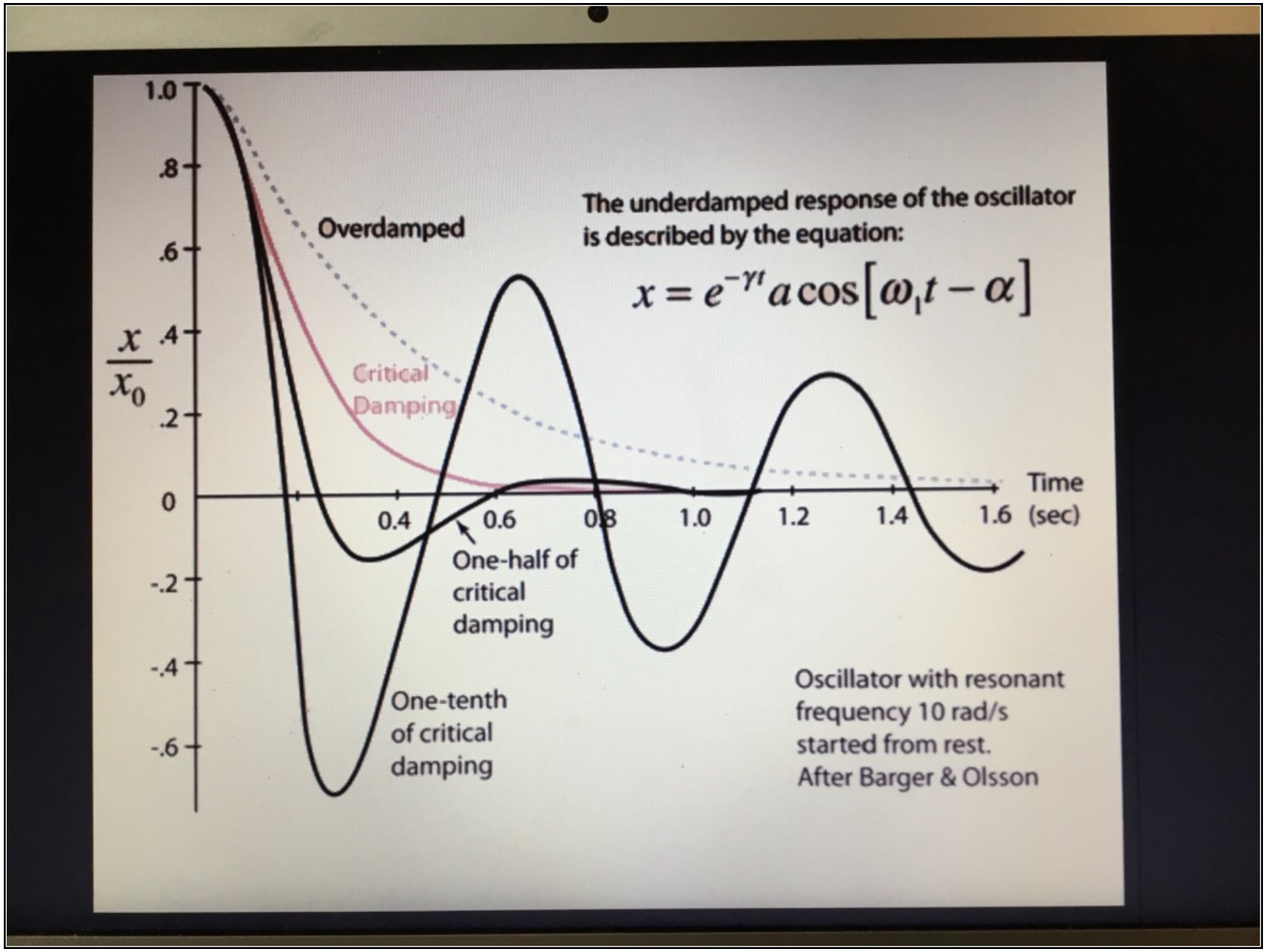
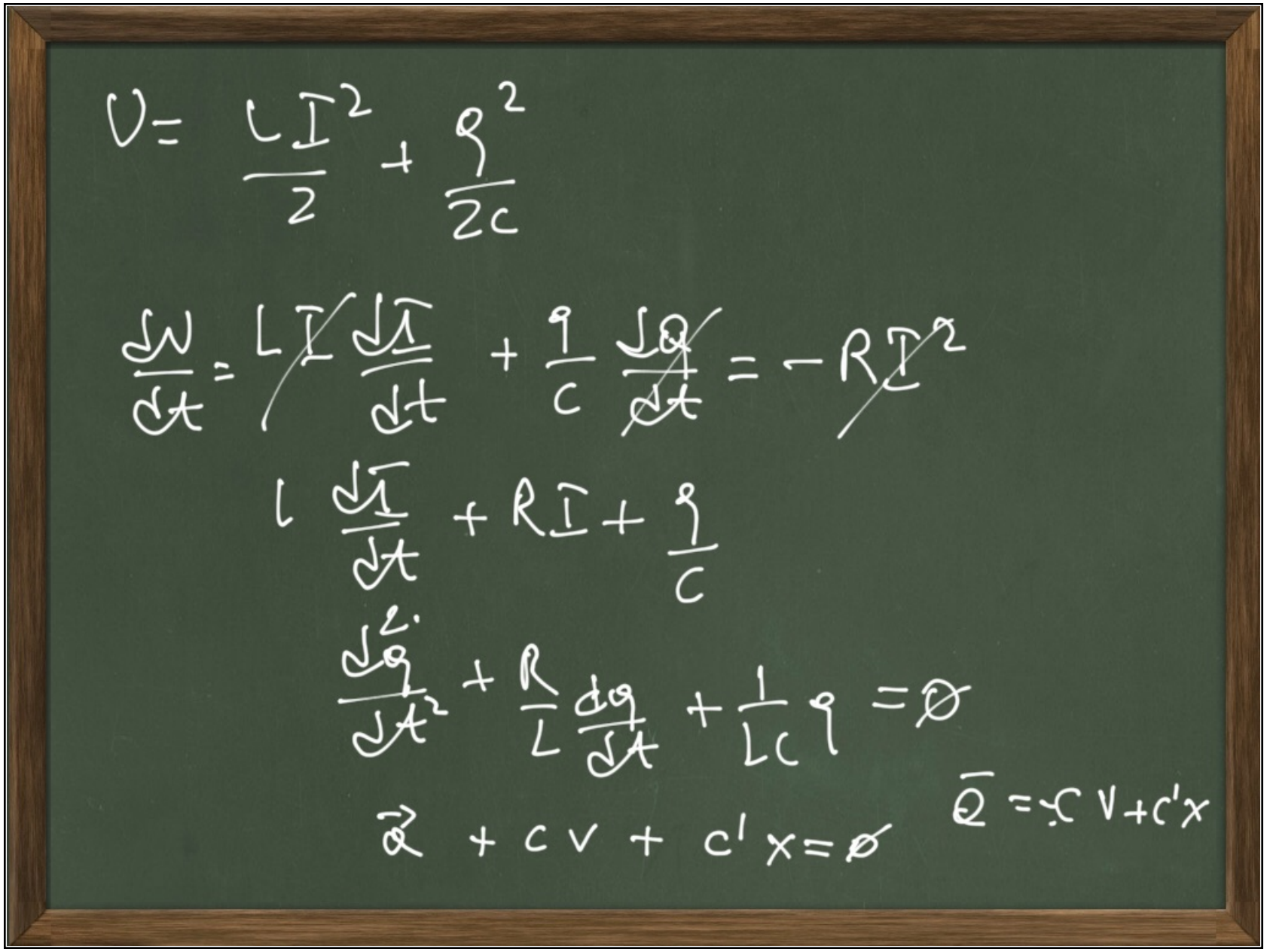

RC eq. statico
RL eq. dinamico
LC oscillazioni
RLC osc. smorzate
RLC elim. osc sm. forzate
q
I
I
I


1.0
.8
.6
.4
.2
0
-.2
-.4
-.6
$\frac{x}{x_0}$
Overdamped
The underdamped response of the oscillator is described by the equation:
$x = e^{-\gamma t} a \cos[\omega_1 t - \alpha]$
Critical Damping
Time (sec)
0.4
0.6
0.8
1.0
1.2
1.4
1.6
One-half of critical damping
One-tenth of critical damping
Oscillator with resonant frequency 10 rad/s started from rest.
After Barger & Olsson


$V = \frac{LI^2}{2} + \frac{q^2}{2C}$
$\frac{dW}{dt} = LI\frac{dI}{dt} + \frac{q}{C}\frac{dq}{dt} = -RI^2$
$L\frac{dI}{dt} + RI + \frac{q}{C}$
$\frac{d^2q}{dt^2} + \frac{R}{L}\frac{dq}{dt} + \frac{1}{LC}q = 0$
$\vec{Q} = CV + C'x$
$\vec{Q} + CV + C'x = 0$

$$ma = m\ddot{x} = -kx - b\dot{x} \qquad k, b > 0$$

$$x = e^{rt} \qquad \dot{x} = re^{rt} \qquad \ddot{x} = r^2 e^{rt}$$

$$mr^2 e^{rt} + k e^{rt} + br e^{rt} = 0$$

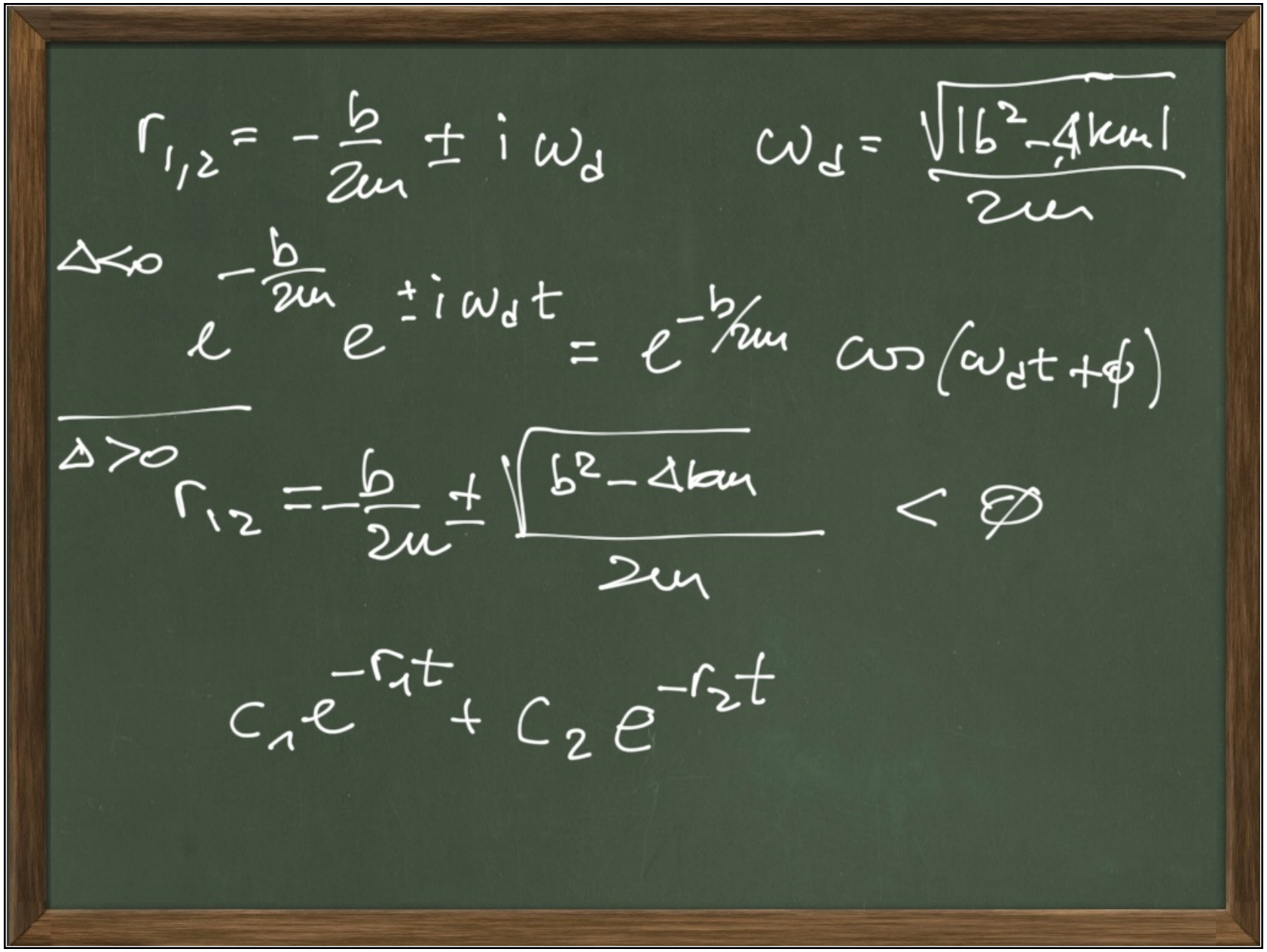
$$mr^2 + br + k = 0$$

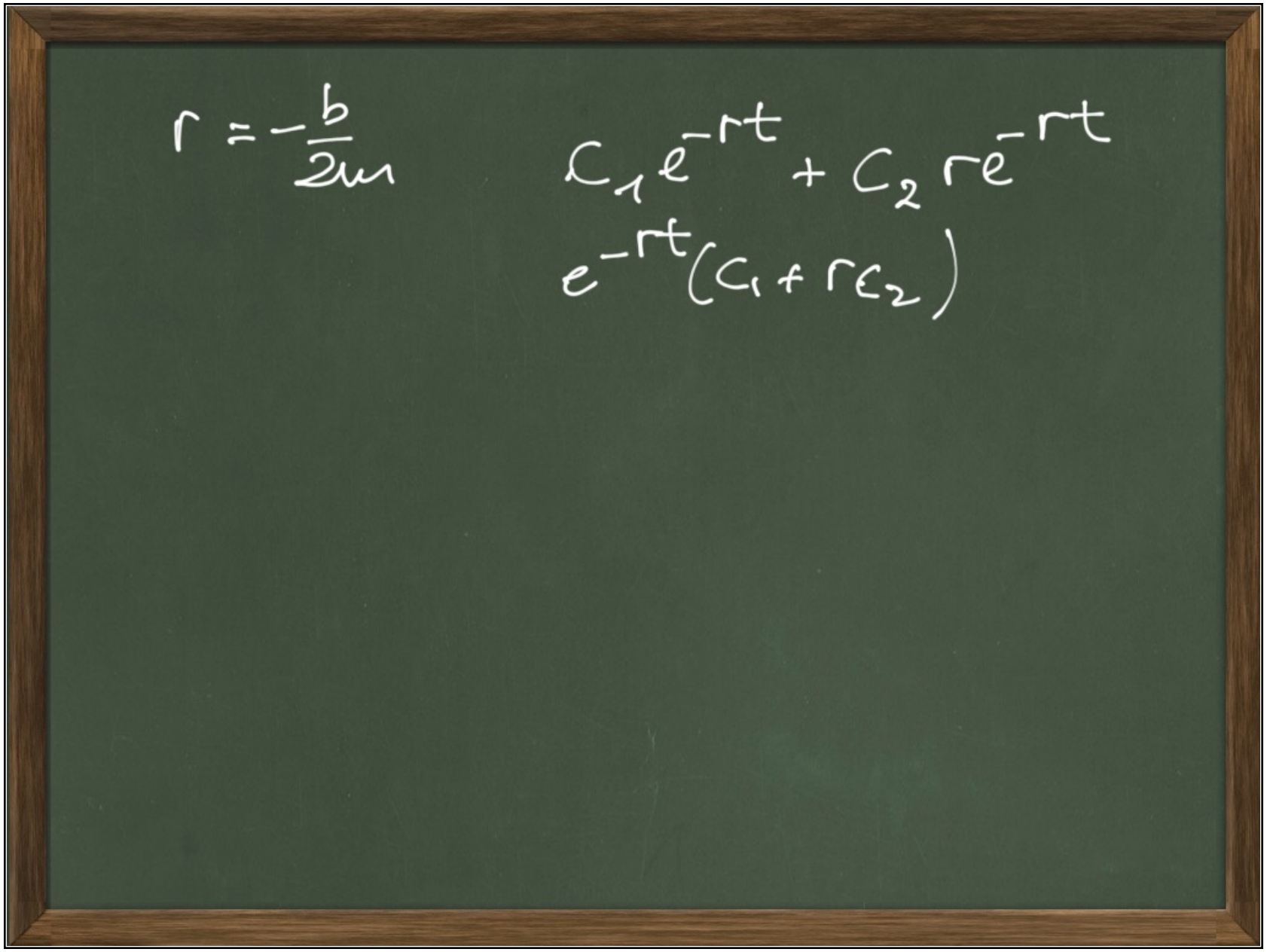
$$r = -\frac{b \pm \sqrt{b^2 - 4km}}{2m}$$

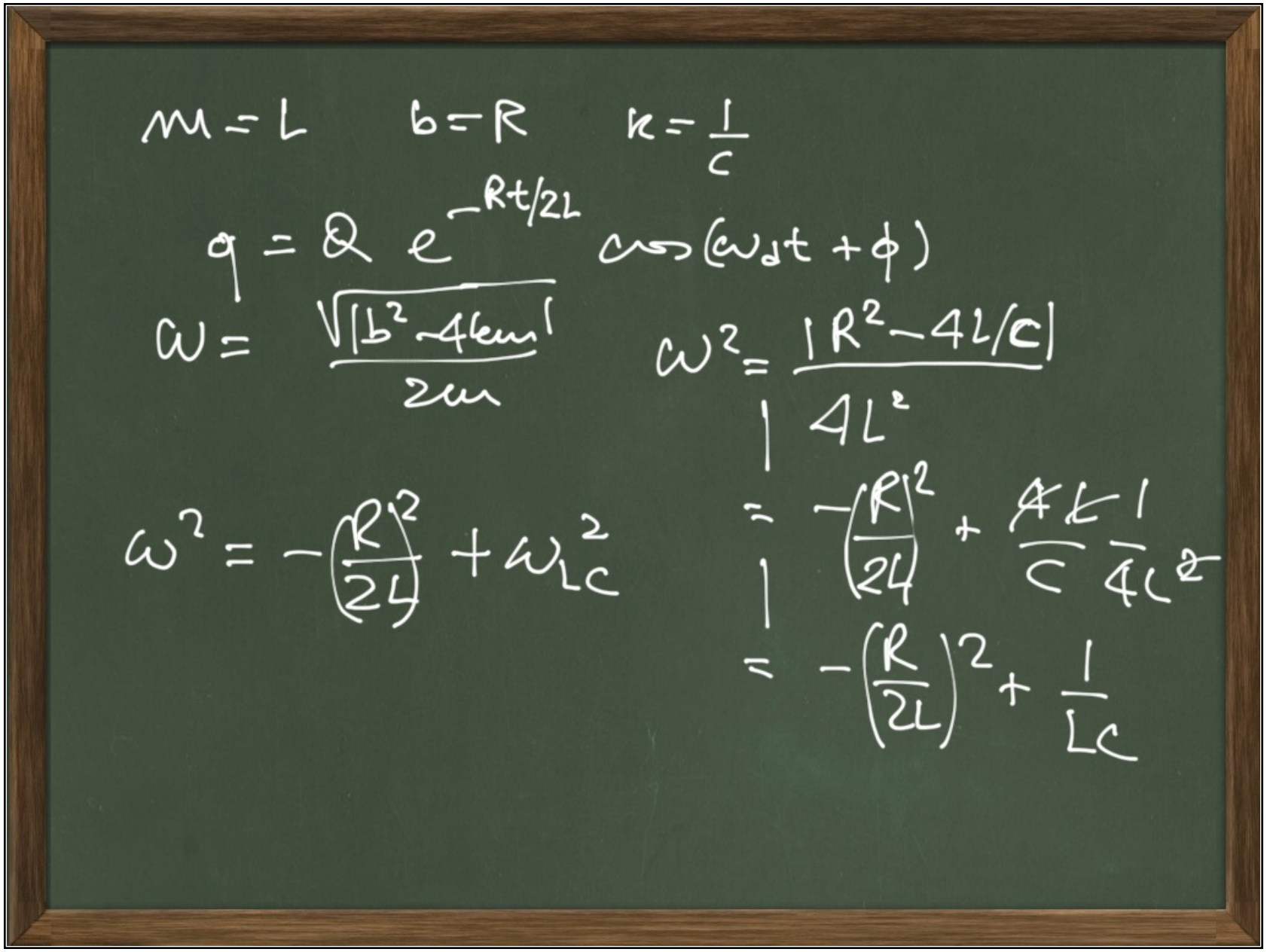
OSC $b^2 < 4km$ sol compl. coniug.

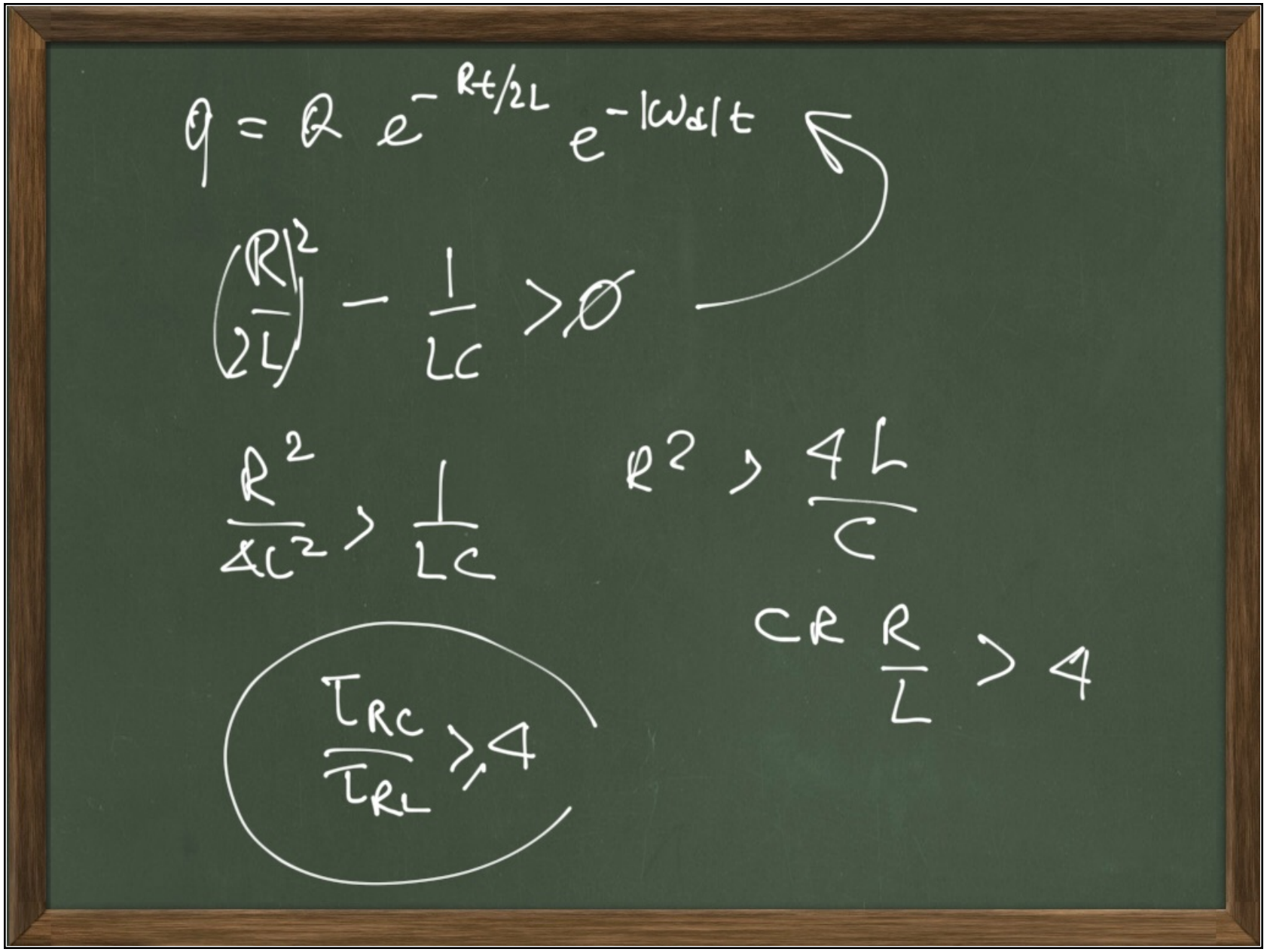
CRITICO $b^2 = 4km$ sol reale multipla

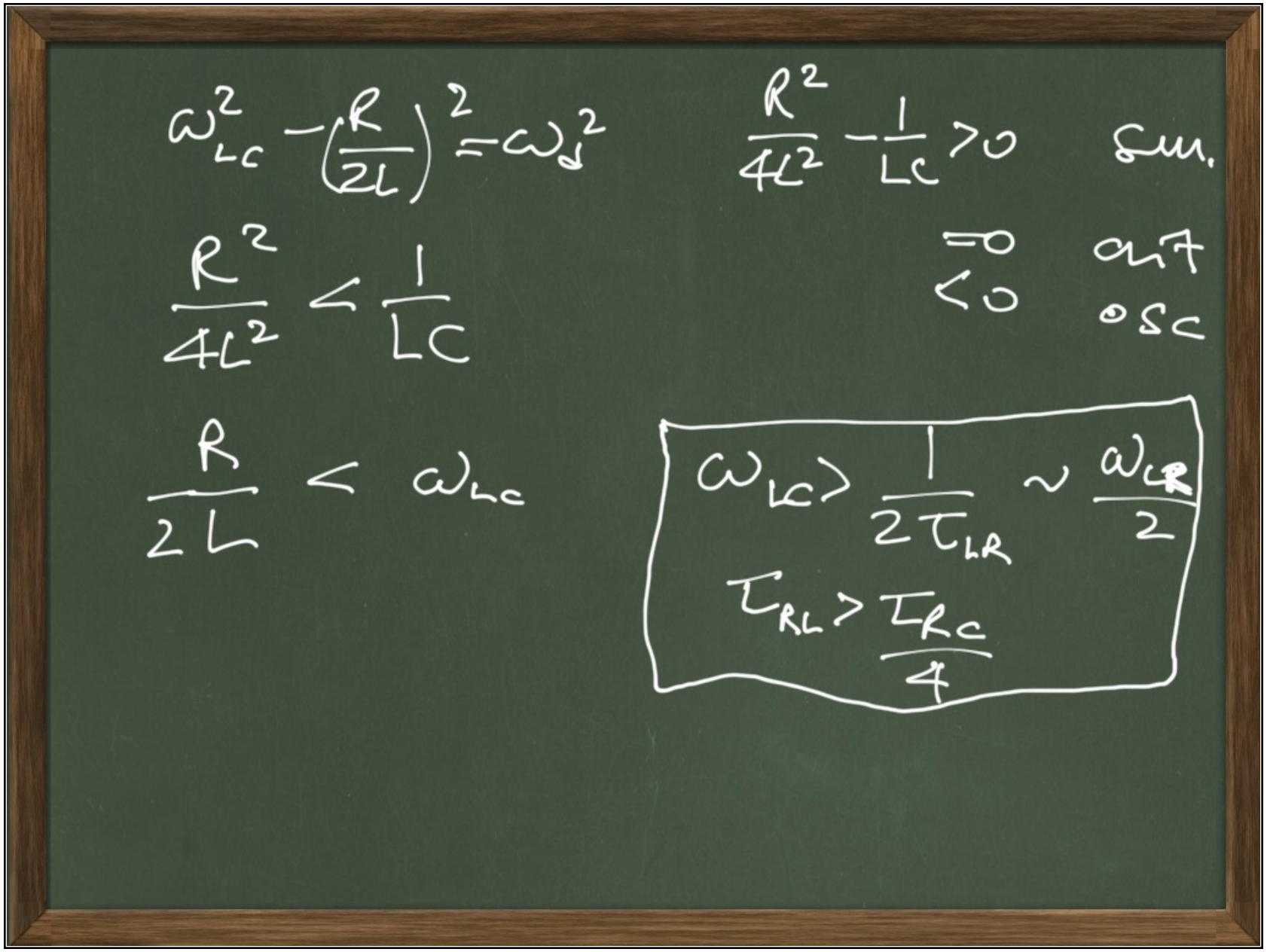
SMORZATO $b^2 > 4km$. 2 sol. reali


$r_{1,2} = -\frac{b}{2m} \pm i\omega_d \qquad \omega_d = \frac{\sqrt{|b^2 - 4km|}}{2m}$
$\Delta < 0 \quad e^{-\frac{b}{2m}} e^{\pm i\omega_d t} = e^{-b/2m} \cos(\omega_d t + \phi)$
$\Delta > 0 \quad r_{1,2} = -\frac{b}{2m} \pm \frac{\sqrt{b^2 - 4km}}{2m} < 0$
$c_1 e^{-r_1 t} + c_2 e^{-r_2 t}$


$r = -\frac{b}{2m}$
$C_1 e^{-rt} + C_2 r e^{-rt}$
$e^{-rt}(C_1 + rC_2)$


m = L b = R k = 1/C
q = Q e^{-Rt/2L} cos(ω_d t + φ)
ω = √|b² - 4km| / 2m
ω² = |R² - 4L/C| / 4L²
ω² = -(R/2L)² + ω_LC²
= -(R/2L)² + 4L/C 1/4L²
= -(R/2L)² + 1/LC


$q = Q e^{-Rt/2L} e^{-i\omega_d t}$
$\left(\frac{R}{2L}\right)^2 - \frac{1}{LC} > 0$
$\frac{R^2}{4L^2} > \frac{1}{LC}$
$R^2 > \frac{4L}{C}$
$CR\frac{R}{L} > 4$
$\frac{\tau_{RC}}{\tau_{RL}} > 4$


$\omega_{LC}^2 - \left(\frac{R}{2L}\right)^2 = \omega_s^2$
$\frac{R^2}{4L^2} - \frac{1}{LC} > 0$ sum.
$= 0$ crit
< 0 osc
$\frac{R^2}{4L^2} < \frac{1}{LC}$
$\frac{R}{2L} < \omega_{LC}$
$\omega_{LC} > \frac{1}{2\tau_{LR}} \sim \frac{\omega_{LR}}{2}$
$\tau_{RL} > \frac{\tau_{RC}}{4}$