Title: PSI 2016/2017 Explorations in Quantum Information - Lecture 15

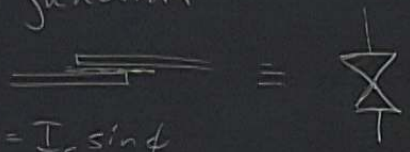
Date: Apr 07, 2017 09:00 AM

URL: http://pirsa.org/17040014

Abstract:

$\Phi_0 = \frac{h}{2e}$, flux quantum.

tunnel junction

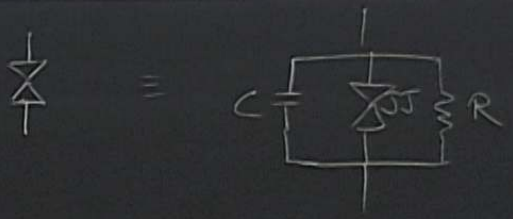


$I = I_c \sin\phi$

phase difference across the junction.

critical current

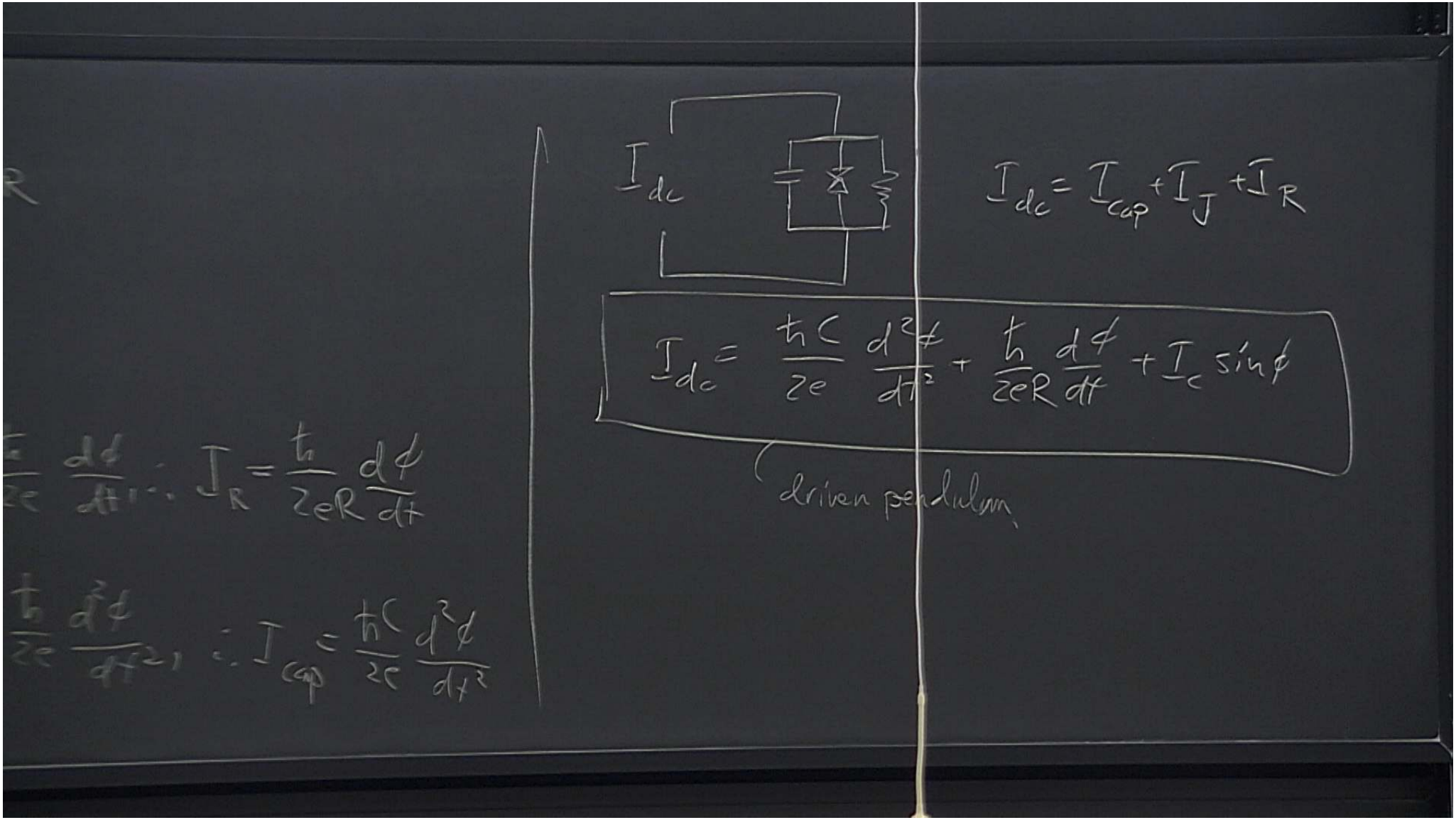
$$\frac{d\phi}{dt} = \frac{2e}{\hbar} V = \frac{2\pi}{\Phi_0} V$$

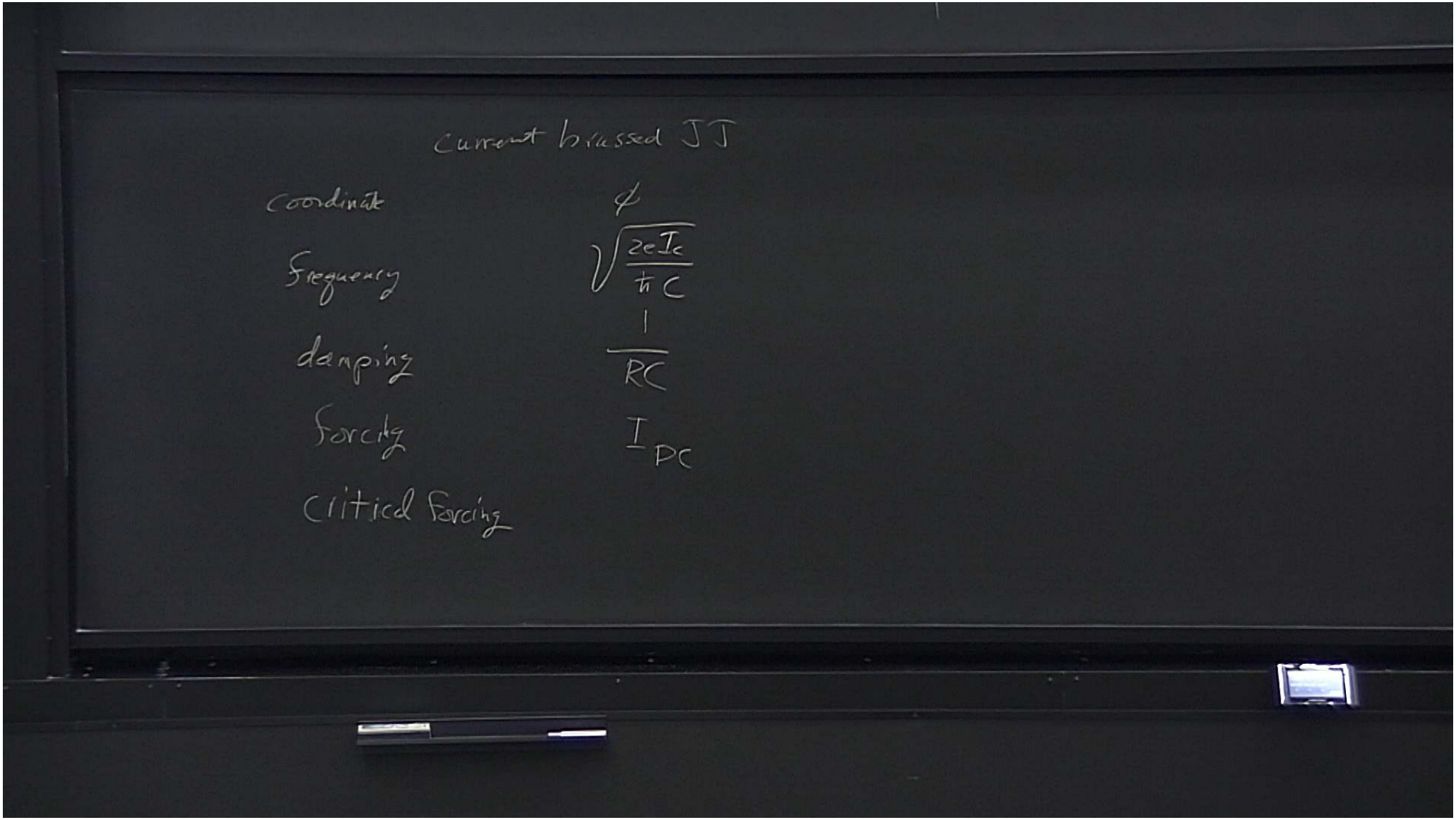


$I_J = I_c \sin\phi$

$I_R = \frac{V}{R}$; $V = \frac{\hbar}{2e}\frac{d\phi}{dt}$ ∴ $I_R = \frac{\hbar}{2eR}\frac{d\phi}{dt}$

$I_c = C\frac{dV}{dt}$; $\frac{dV}{dt} = \frac{\hbar}{2e}\frac{d^2\phi}{dt^2}$ ∴ $I_{cap} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$


I_{dc}
$I_{dc} = I_{cap} + I_J + I_R$
$I_{dc} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} + I_c \sin\phi$
driven pendulum
$\frac{\hbar}{2e}\frac{d\phi}{dt} \therefore I_R = \frac{\hbar}{2eR}\frac{d\phi}{dt}$
$\frac{\hbar}{2e}\frac{d^2\phi}{dt^2} \therefore I_{cap} = \frac{\hbar C}{2e}\frac{d^2\phi}{dt^2}$


Current biassed JJ
Coordinate
ϕ
Frequency
$\sqrt{\frac{2eI_c}{\hbar C}}$
damping
$\frac{1}{RC}$
Forcing
I_{DC}
Critical Forcing

current biassed JJ

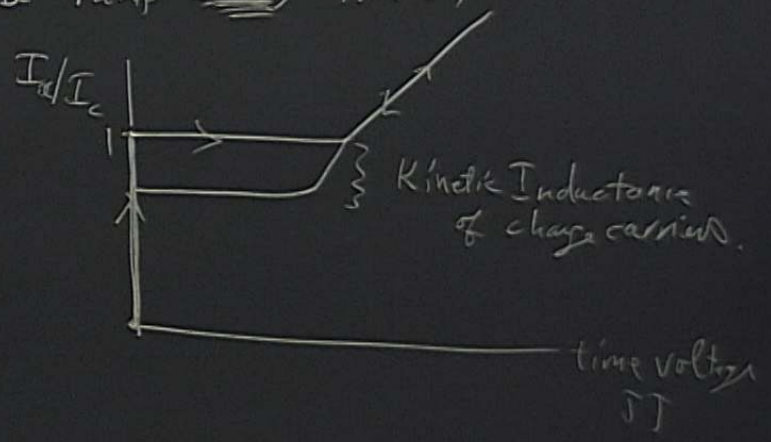
over the JJ

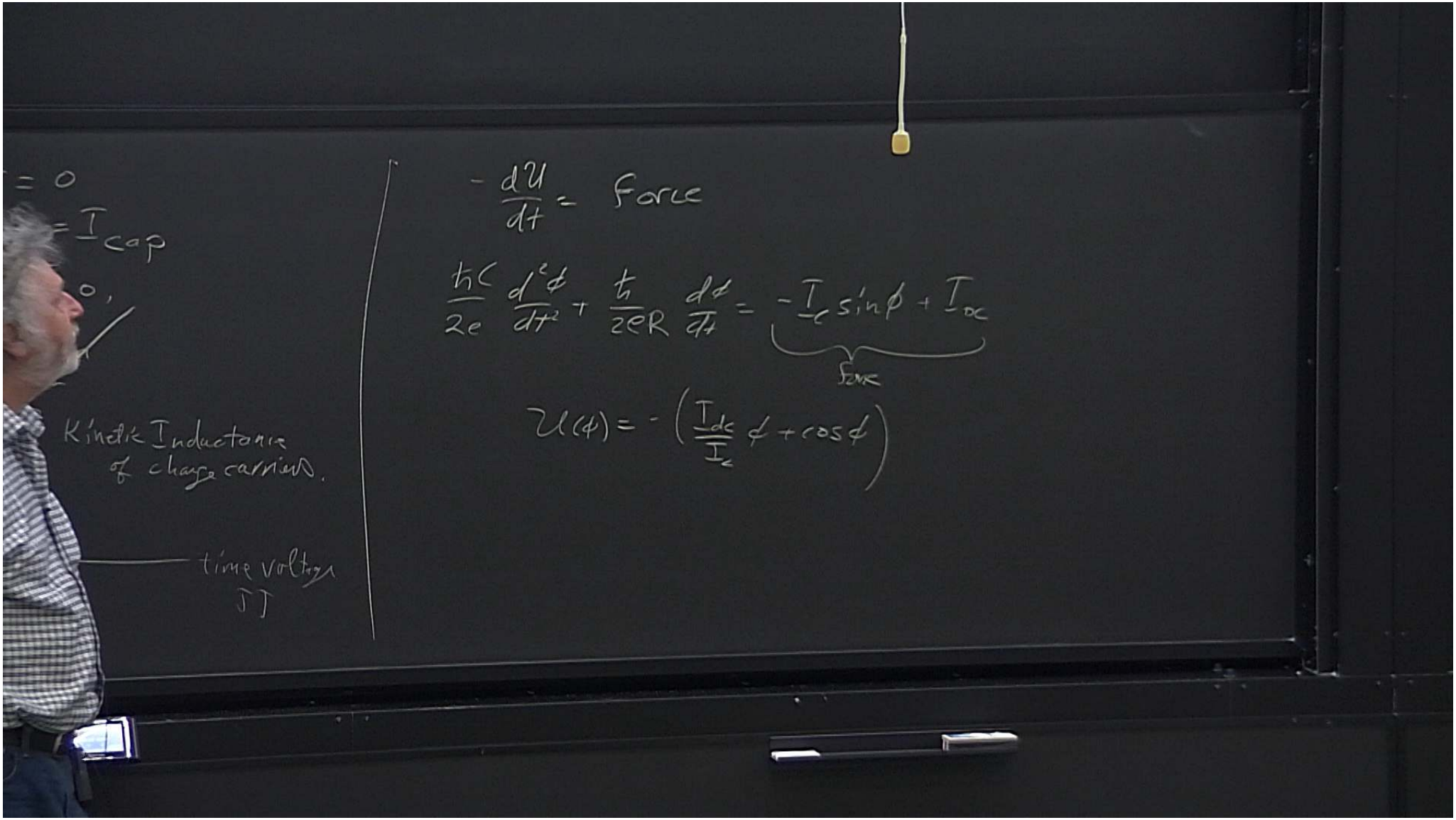
Coordinate	ϕ
Frequency	$\sqrt{\frac{2eI_c}{\hbar C}}$
damping	$\frac{1}{RC}$
forcing	I_{DC}
critical forcing	$I_{DC} = I_c$

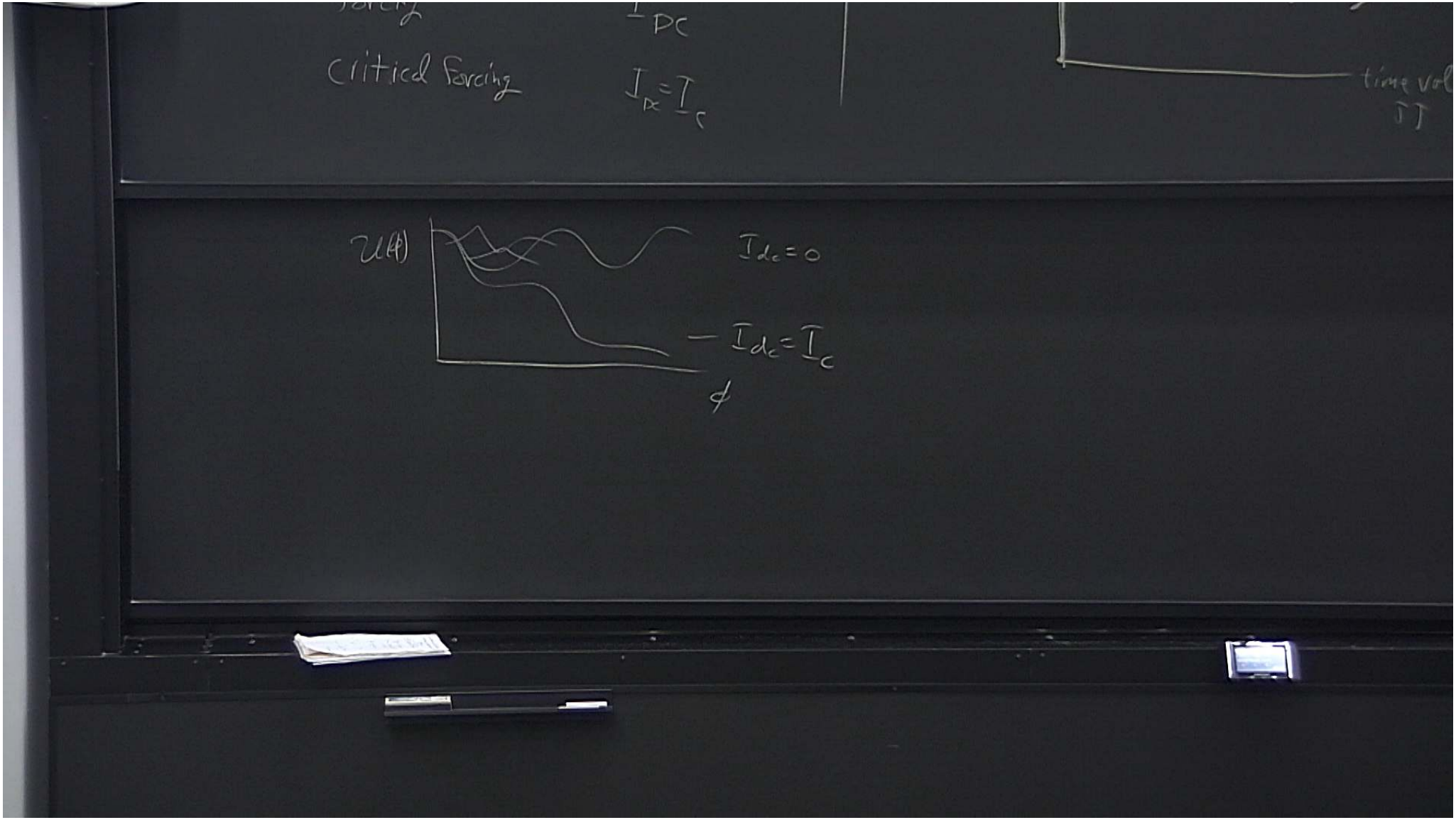
$I_{DC} < I_c$, $V = 0$

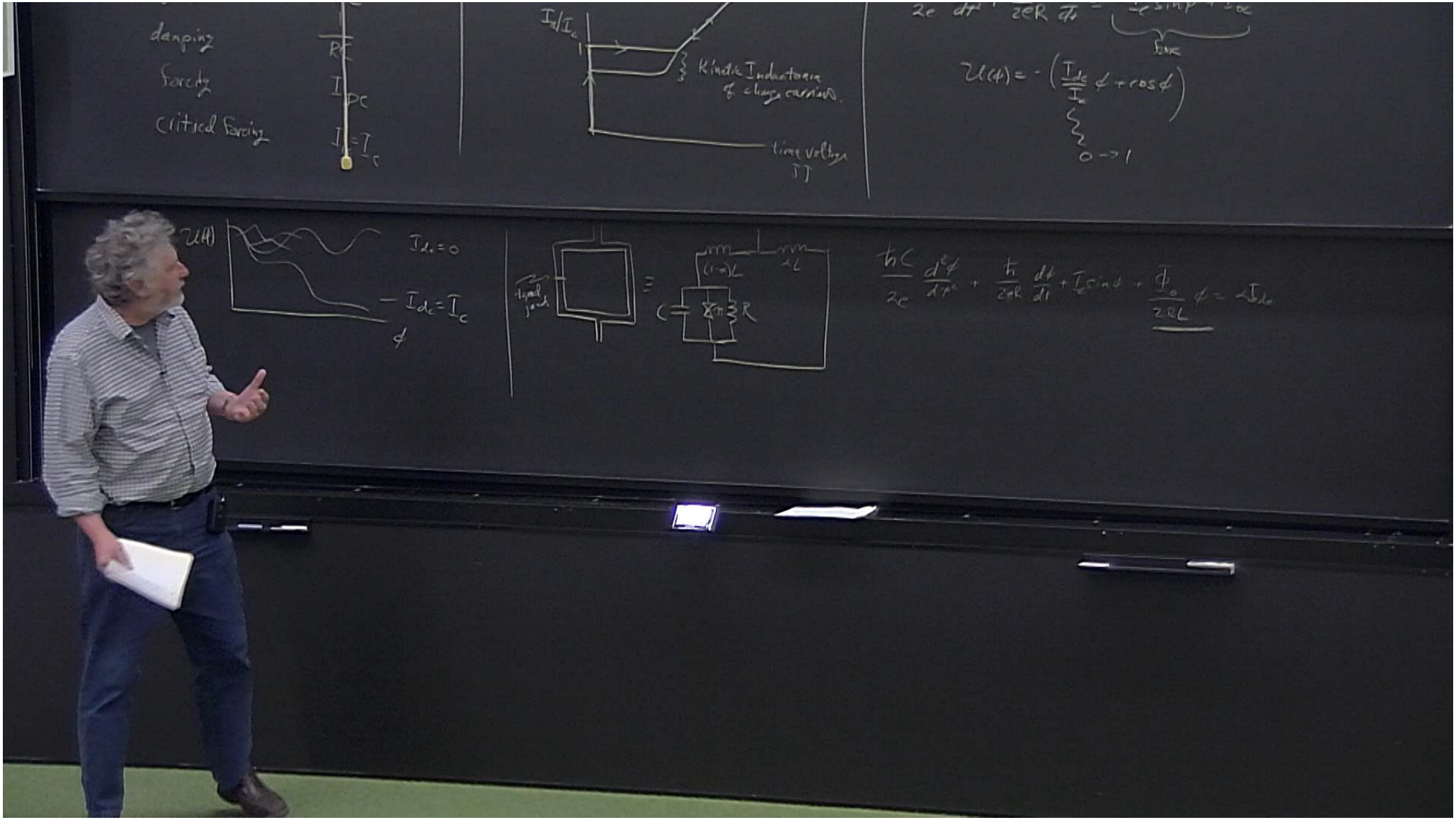
$\therefore I_R = 0 = I_{cap}$

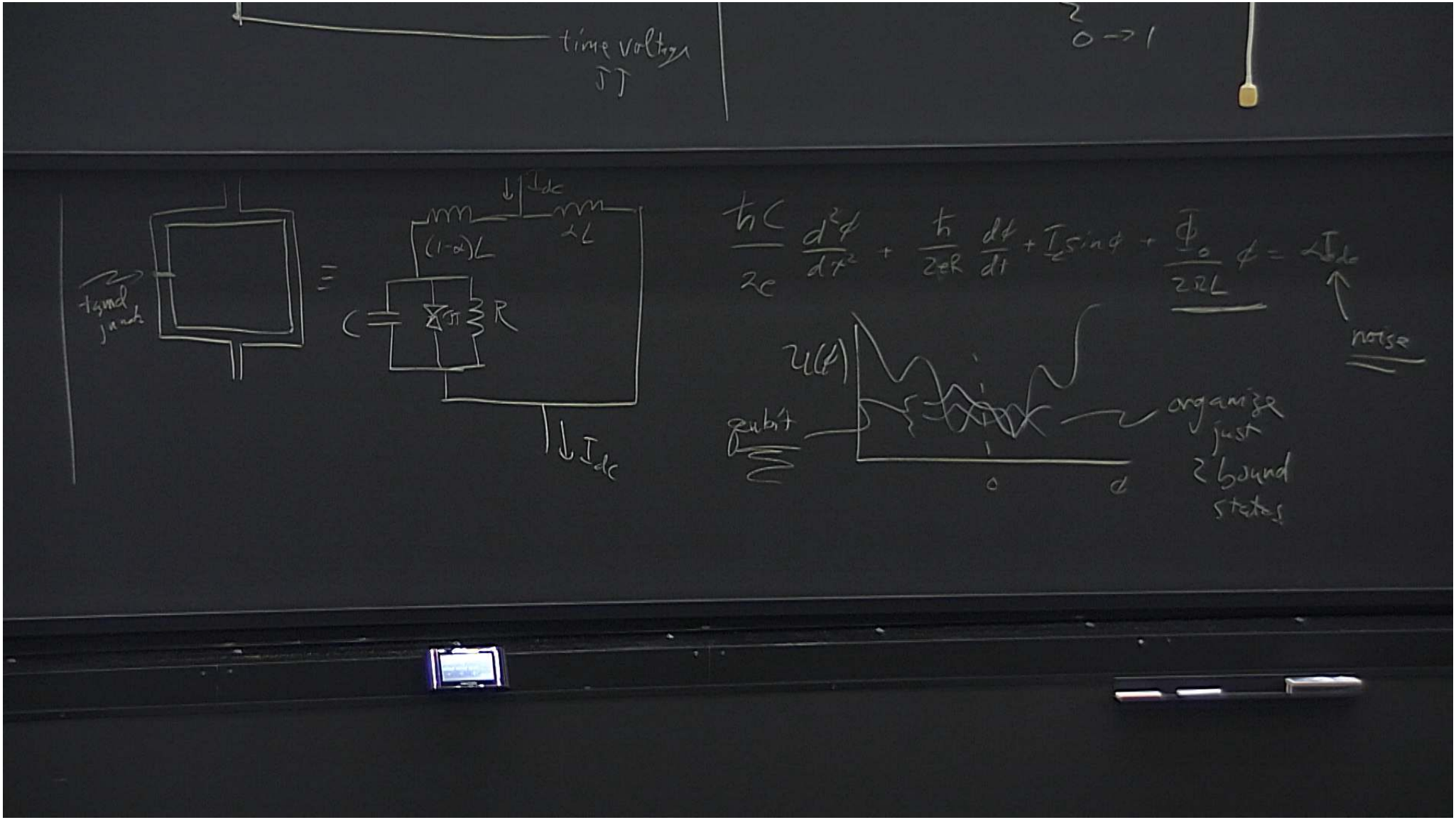
take I_{DC} ramp slowly from 0,

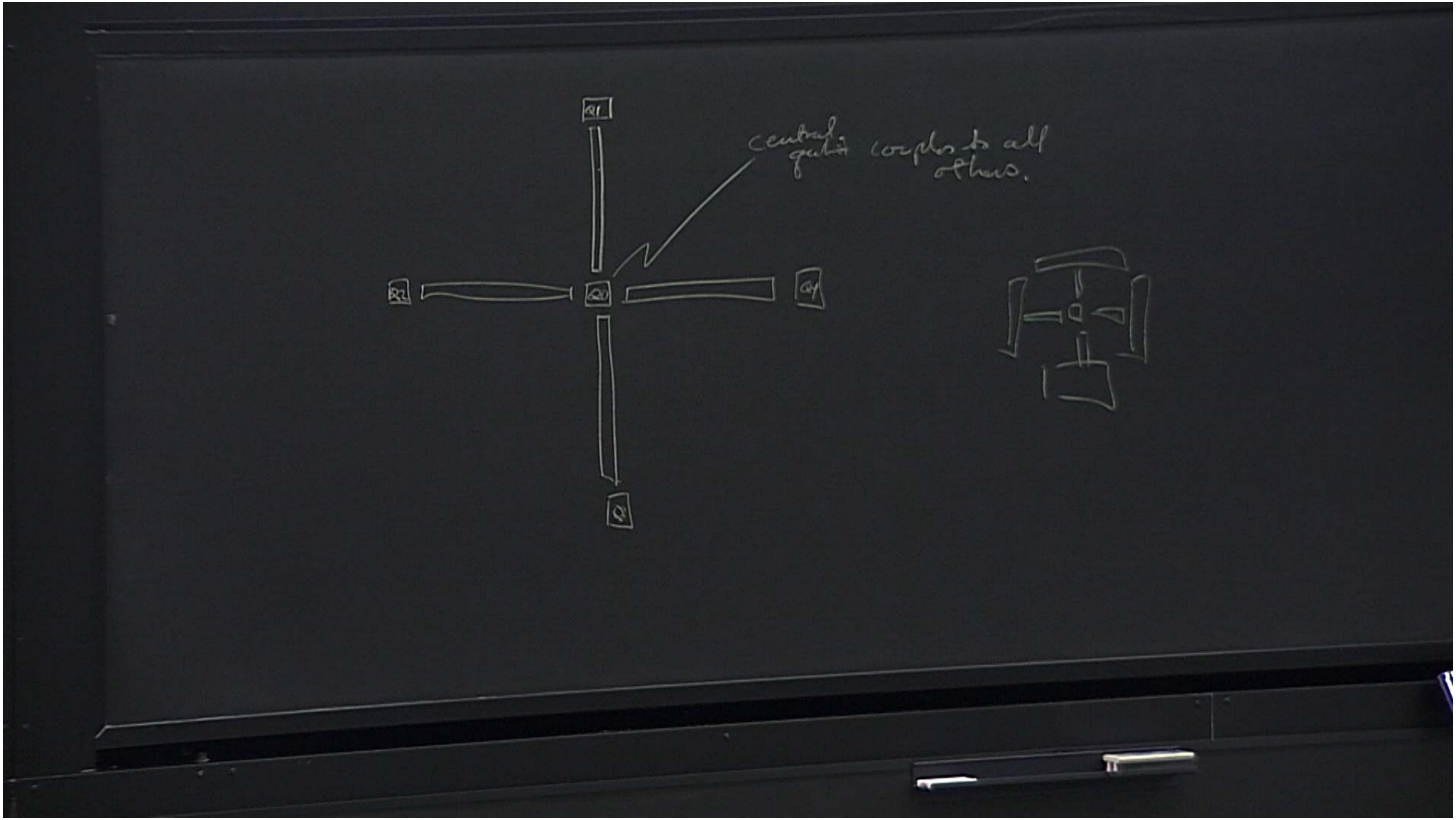



= 0
= I cap
0,
Kinetic Inductance
of charge carriers.
time voltage
JJ
$-\frac{dU}{dt}$ = force
$\frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} = \underbrace{-I_c \sin\phi + I_{dc}}_{F_{DRIVE}}$
$U(\phi) = -\left(\frac{I_{dc}}{I_c}\phi + \cos\phi\right)$


critical forcing
$I_{dc} = I_c$
$U(\phi)$
$I_{dc} = 0$
$I_{dc} = I_c$
ϕ


damping
Forcing
Critical Forcing
I_{dc}/I_c
Kinetic Inductance of charge carriers.
time
voltage
$U(\phi) = -\left(\frac{I_{dc}}{I_c}\phi + \cos\phi\right)$
$0 \to 1$
$U(\phi)$
$I_{dc}=0$
$I_{dc}=I_c$
ϕ
equal
$\frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} + I_c\sin\phi + \frac{\Phi_0}{2\pi L}\phi = \frac{\pi}{}I_{dc}$


time voltage
JJ
0 -> 1
I_{dc}
$(1-\alpha)L$
αL
tunnel junction
C
JJ
R
I_{dc}
$\frac{\hbar C}{2e}\frac{d^2\phi}{dt^2} + \frac{\hbar}{2eR}\frac{d\phi}{dt} + I_c \sin\phi + \frac{\Phi_0}{2\pi L}\phi = \frac{I_{dc}}{\text{noise}}$
U(t)
qubit
organize just 2 bound states
0
d


central qubit couples to all others.