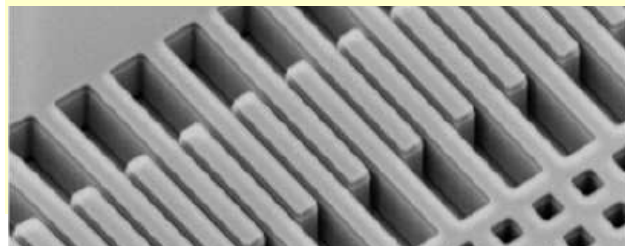
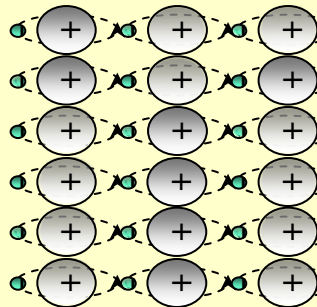
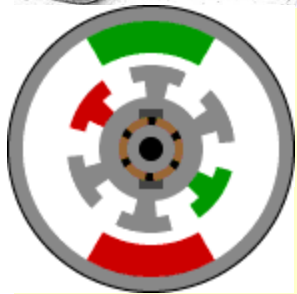
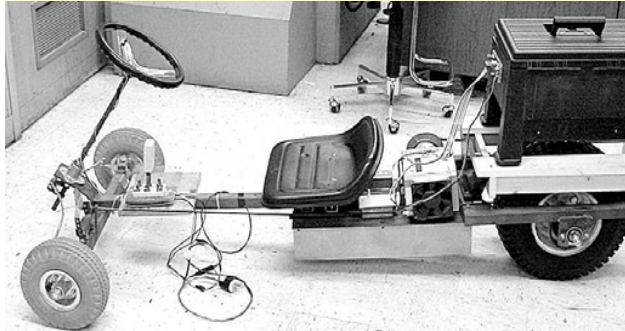


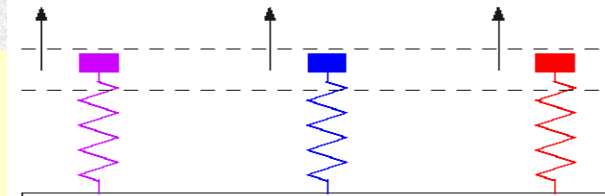
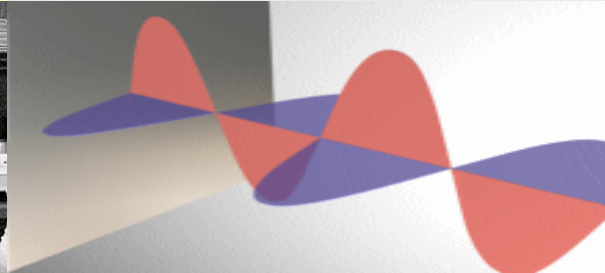
6.007 - Applied E&M - From Motors to Lasers

The course encompassed THREE THEMES with FIVE related LABS

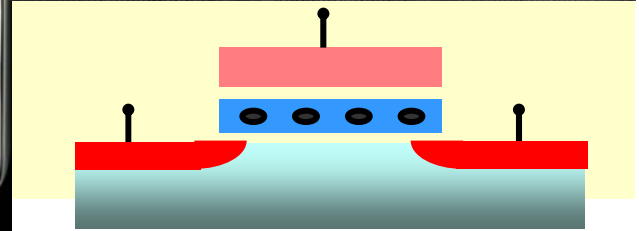
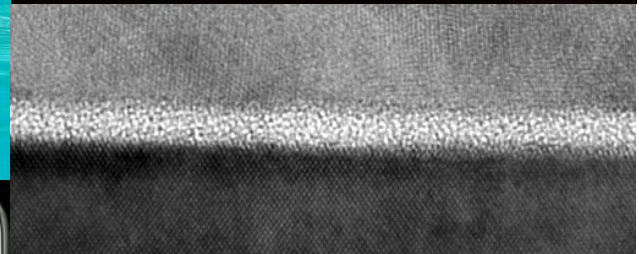
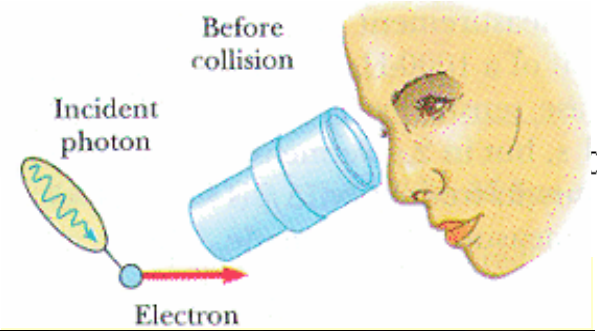
WORK AND ENERGY



ELECTRODYNAMICS



QUANTUM MECHANICS



Macroscopic phenomena and microscopic processes: Student understanding of transients in direct current electric circuits

Beth Ann Thacker

Department of Physics, Grand Valley State University, Allendale, Michigan 49821

Uri Ganiel²⁾

Department of Physics, The Ohio State University, Columbus, Ohio 43210

Donald Boys

Department of Physics, University of Michigan-Flint, Flint, Michigan 48802

(Received 11 December 1997; accepted 6 April 1999)

Studies of student understanding of simple electric dc circuits have shown that many of them find it very difficult to apply qualitative reasoning to explain the observed phenomena. It has been suggested that these difficulties may be due to their failure to construct models of microscopic processes that lead to these phenomena. Indeed, in the traditional courses, such models have generally not been emphasized. In the present study, we compared the performance of different groups of university students in answering a questionnaire designed to probe their understanding of the relationship between macroscopic phenomena of transients in a dc circuit and the microscopic processes that can explain these phenomena. One group studied from a traditional text, the second group used a recently developed text that emphasizes models of microscopic processes. We also conducted detailed interviews with some of the students. From an analysis of the performance of these two groups, and also from a comparison with a previous study on Israeli high school students, we found that most of the students whose instructional experiences included an emphasis on the development of models of microscopic processes developed a better understanding of the transient phenomena studied. They applied qualitative considerations in their analyses and were able to develop coherent models to describe their observations. Overall, they demonstrated a superior understanding of the physical phenomena. © 1999 American Association of Physics Teachers.

6.007 - Applied E&M - From Motors to Lasers

GUIDELINES:

- Integral Maxwell's Equations
- 1-D Problems
- Exposure to Modern Problems
- Microscopic Physics to Support Engineering Systems
- Macro/Microscopic Intuition



6.007 - Applied E&M - From Motors to Lasers

The course encompassed THREE THEMES with FIVE related LABS

WORK AND ENERGY

ENERGY CONVERSION and STORAGE

- Energy Conservation
- Across and Through Vars.
- Energy Storage

•• LAB: MOTORS ••

ENERGY/POWER/WORK in BASIC CIRCUIT ELEMENTS

- Energy Method ***
- Electric/Magnetic Materials
- Magnetostatic / Electrostatic Machines
- Micro-Electro Machines

•• LAB: COIL GUN ••

- Limits of Statics

ELECTRODYNAMICS

EM WAVES

- Wave Equation
- Energy in the EM Waves
- Polarized Light

MATERIALS RESPONSE

- Lorentz Oscillator ***
- Reflection, Absorption
- Complex Refractive Index
- Evanescent Waves

•• LAB ••

LIQUID CRYSTAL DISPLAY

DEVICES AND PHYSICS

- Polarizers/Birefringence

•• LAB: FIBEROPTICS ••

- Photon as a Quantum of Energy

QUANTUM MECHANICS

MEASUREMENT AND UNCERTAINTY

- Wavepackets
- Photon Momentum
- Heisenberg Microscope

ELECTRON EIGENSTATES

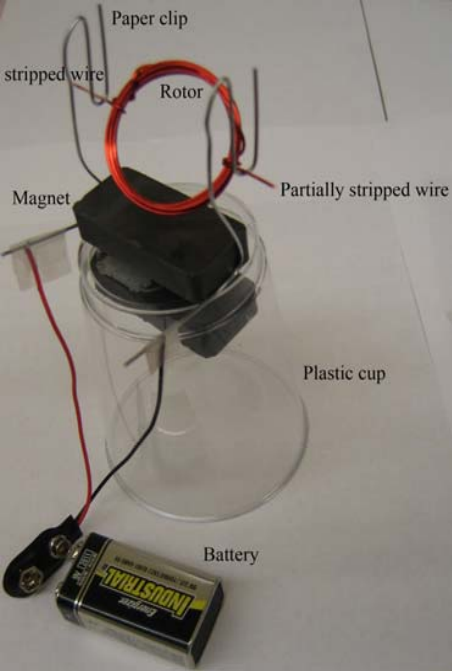
- Calculating Wavefunctions
- Particle in a Box
- Atoms and Quantum Dots

QUANTUM ELECTRONICS

- Tunneling (STM, Flash) ***
- Energy Bands/ Conduction
- Energy Band Transitions
- Photodetectors, Solar Cells
- LED and Lasers

•• LAB ••

TUNNELING TOUCHPAD



MOTOR LAB

Motors and Actuators

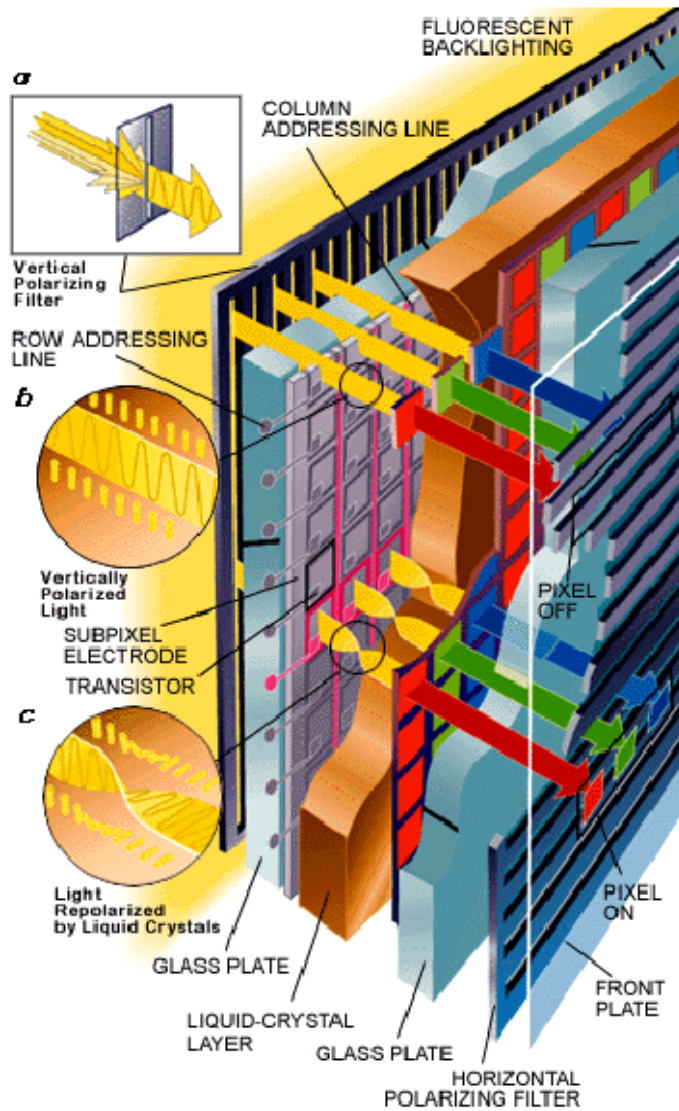
- Hands-on lab experience essential for adoption of engineering practice
- Engage in the first week of the semester
- Use the energy method in actuator analysis



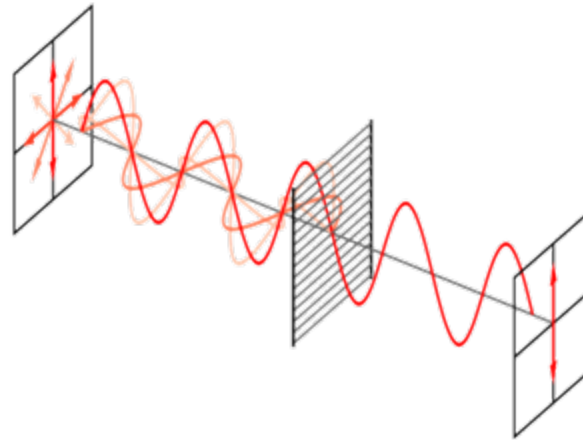
COIL GUN LAB



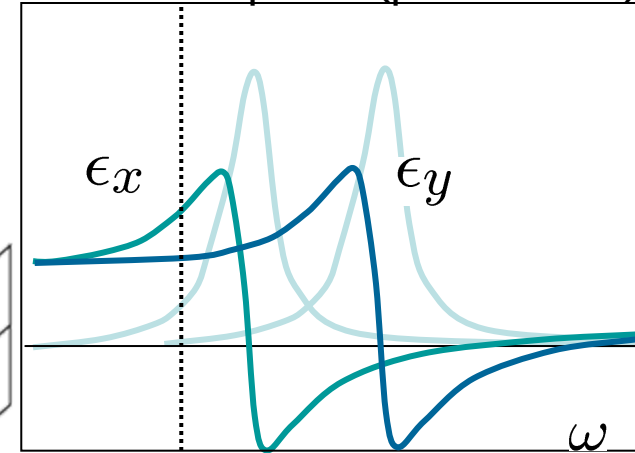
Anatomy of an LCD Display



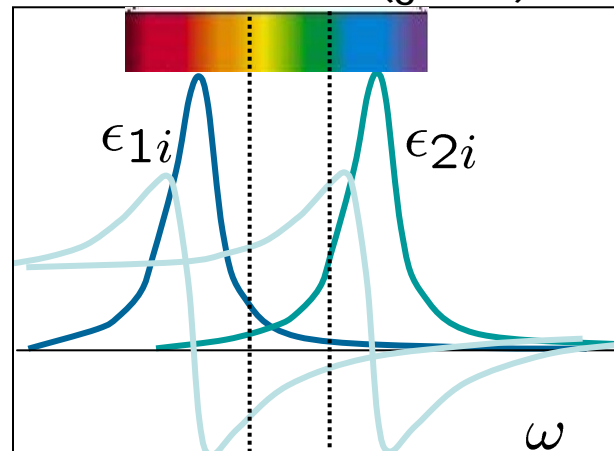
Polarizers



Retardation plate (pol rotator)



Color Filter (green)



Backlight (lightguide)



~ Example: 6.007 Concepts Pertaining to Liquid Crystal Displays ~

INDEX OF REFRACTION

- Physical origins
 - molecular dipoles
 - polarizability (Lorentz Oscillator)
- Isotropic solids
 - Snell's Law
 - Waveguides (total internal reflection)
 - Reflection, Transmission, Absorption (Fresnel Equations)
 - Color of solids
- Anisotropic solids - Birefringence
 - o Liquid Crystals

POLARIZERS, POLARIZED LIGHT

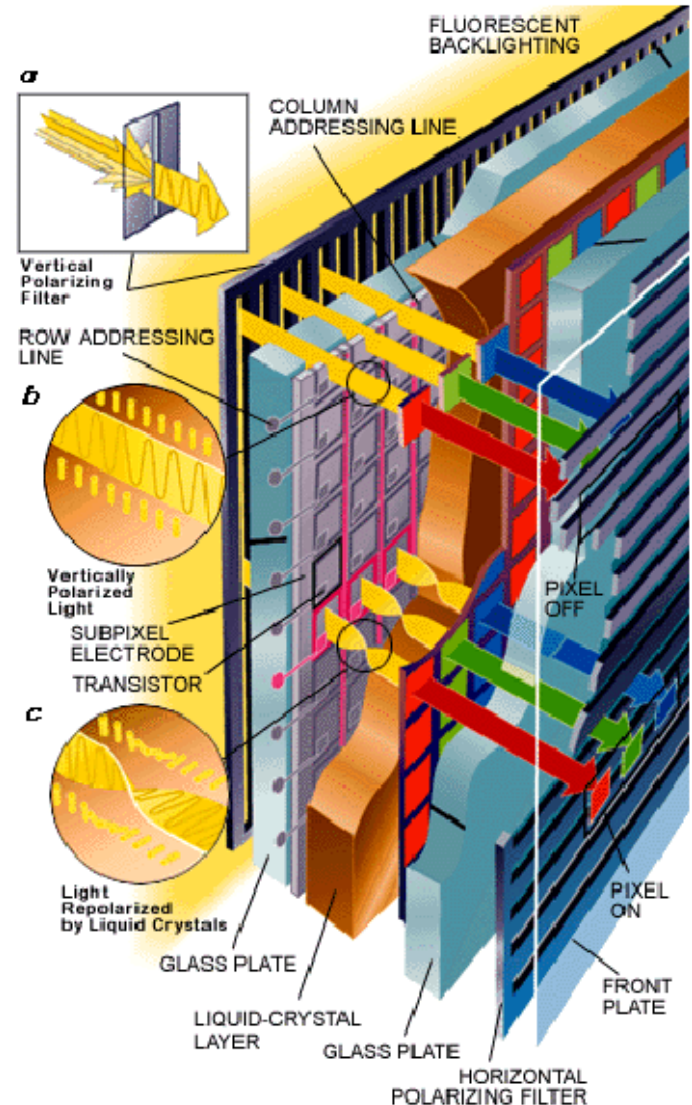
- Wire polarizer, Polaroid polarizer
- Circularly, Linearly polarized light

LIGHT SOURCES

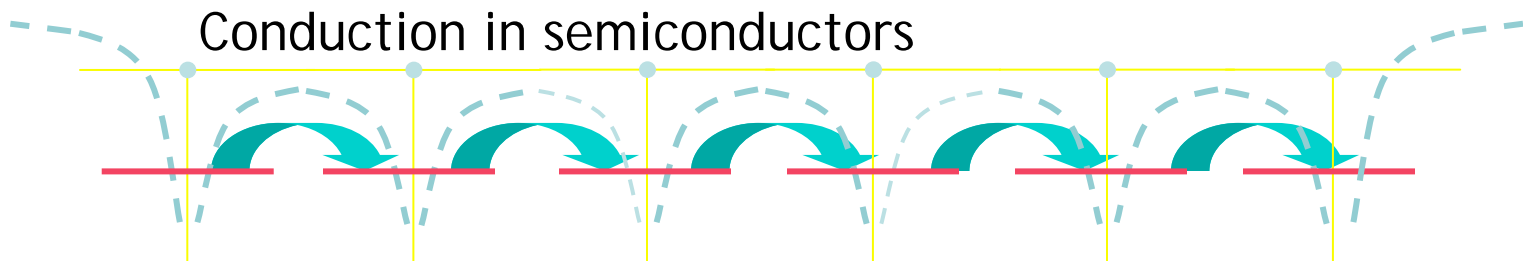
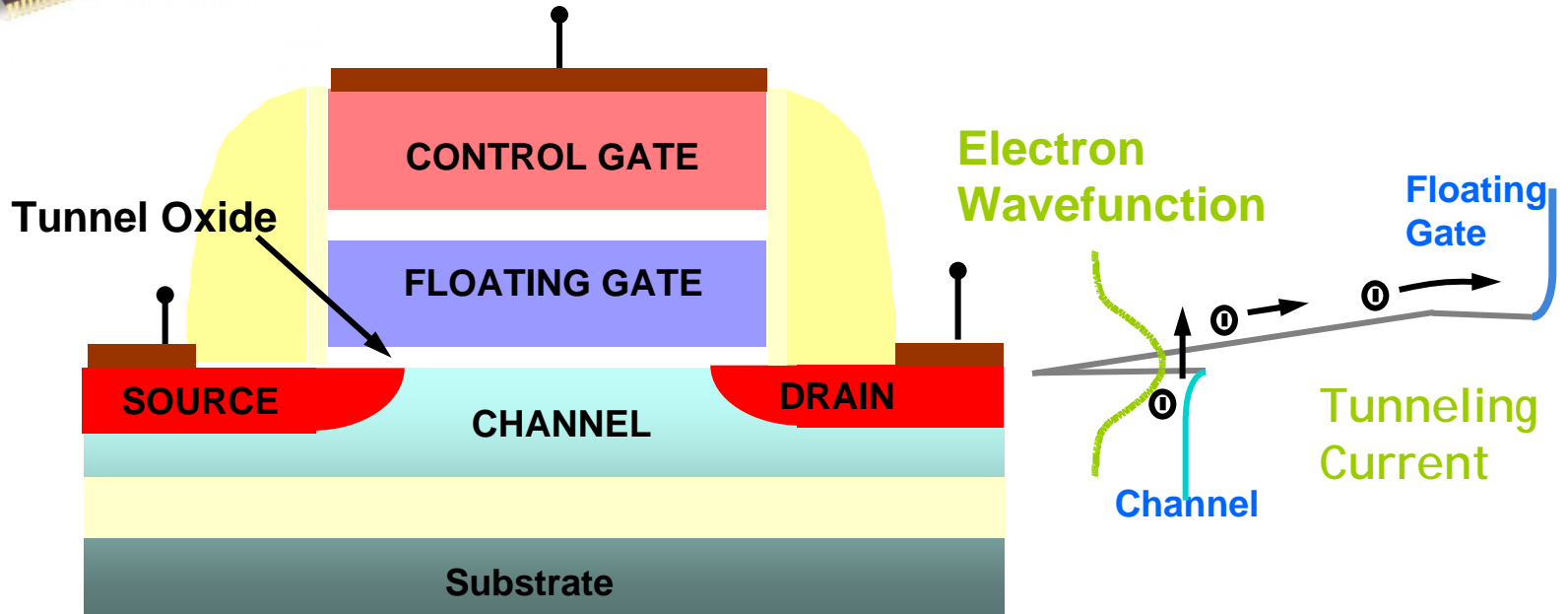
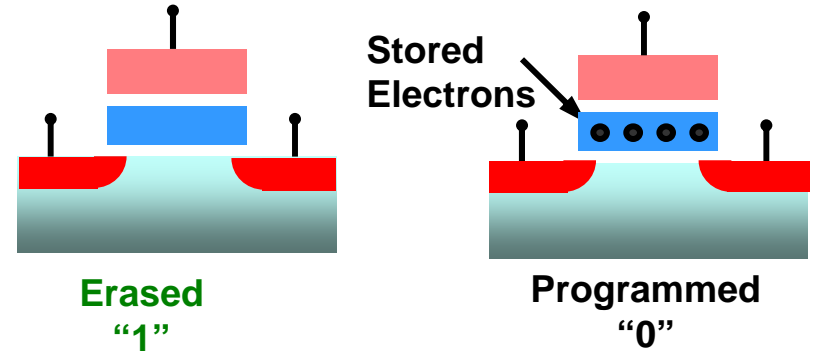
- Visible and IR/UV spectrum
- Spectral emission of Incandescents, Fluorescents, LEDs
- Energy efficiency of light sources

LCD DISPLAYS

- Eye response, Perception of Color
- Light Guide
- Passive/Active Matrix Display Electronics



Anatomy of an Flash Memory



~ Example: 6.007 Concepts Pertaining to Flash Memory Technology ~

CHARGE and FIELDS

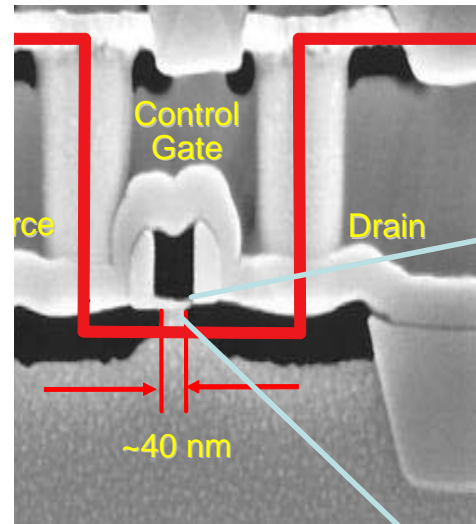
- Free and Fixed Charge in Materials
- Metals, Semiconductors, Insulators
- Free Charge Transport

QUANTUM MECHANICS

- Moore's Law Scaling
- Bound Electrons
- Tunneling through a Potential Barrier

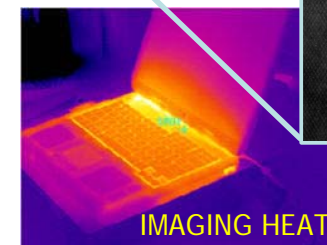
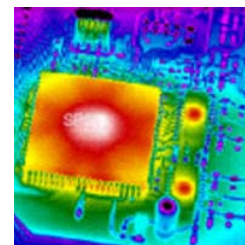
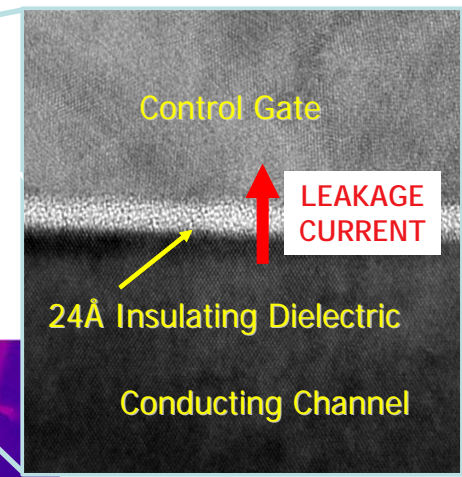
CIRCUIT ELEMENTS

- Field Effect Transistors
- Flash Memory
- Capacitors, Resistors



CONDUCTION ELECTRON FLOW

Tunneling causes thin insulating layers to become leaky !



6.007^F

*License to Master EM and QM
for Tomorrow's Technologies*

6.728

Applied Quant. & Stat. Mech.
(from quantum wells
to molecules)

6.013

EM Applications
(wireless comm., antennas,
sensors, fiberoptics, MEMS)

6.012

Semiconductor Devices
(FETs, BJTs, p-n Diodes,
amplifiers)

6.730

Solid State Applications Phys.
(electrons and lattice
vibrations in solids)

6.602

Fundamentals of Photonics
(lasers, integrated optics,
quantum electronics)

6.701

Intro to Nanoelectronics
(transistors at
the nanoscale)

⋮