6.007 – Applied E&M – From Motors to Lasers

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with contributions from Prof. Steve Leeb & Prof. David Staelin

The course encompasses THREE THEMES with FOUR related LABS
(1) WORK and ENERGY (2) Applied ELECTROMAGNETICS (3) Applied QUANTUM MECHANICS

WORK AND ENERGY THEME

ENERGY CONVERSION
- Motors (gas vs. electric)
- Energy Storage

1st LAW of THERMODYNAMICS

ENERGY/POWER/WORK in BASIC CIRCUIT ELEMENTS
- Polarization / Magnetization
- Transformers

PRINCIPLE of VIRTUAL WORK
- Energy / Co-Energy

EXAMPLES
- Speaker / Solenoid
- Homopolar Motor
- Commutator Machine
- Synchronous Machine
- Nuclear Magnetron

ELECTROMAGNETICS THEME

WIRELESS COMMUNICATIONS
- Antennas
- Near and Far Field Interactions
- Energy per Bit of Information

MAXWELL's EQUATIONS
- Boundary Conditions
- Energy Loss and Dispersion
- Superposition of Fields

EM FIELDS in WIRED APPLICATIONS
- Sinusoidal Waves
- Wired Communication Systems
- Coaxial Lines
- Optical Wavegides
- Electronic Circuits and Systems
- Microwave Ovens

APPLIED QUANTUM MECHANICS

MANIFESTATIONS of QUANTUM MECHANICS
- Photon Momentum
- Heisenberg Microscope / Uncertainty
- Electron Diffraction

ELECTRON WAVEFUNCTION
- Schrödinger's Equation
- Particle in a box (nano-sized box)
- Atoms, Molecules, Quantum Dots
- Color of Materials
- Charge Tunneling in Nanoscale Structures

APPLICATION of QUANTUM MECHANICS in TODAY's ELECTRONICS
- Energy Bands
- Light Sources (Incandescent, LED)
- Lasers
- Conduction of Charges in Solids
- Today's Flash Memory Technology

Example: 6.007 Concepts Pertaining to LCDs

INDEX OF REFRACTION

- **Physical origins**
  - molecular dipoles
  - polarizability
- **Isotropic solids**
  - Snell's Law
    - total internal reflection
    - waveguides (slab, fibers)
  - Reflection, Transmission, Absorption (Beer's Law)
  - Color of solids
- **Anisotropic solids**

POLARIZERS

- Wire polarizer
- Polymer polarizer (ex: sunglasses)

LIQUID CRYSTALS

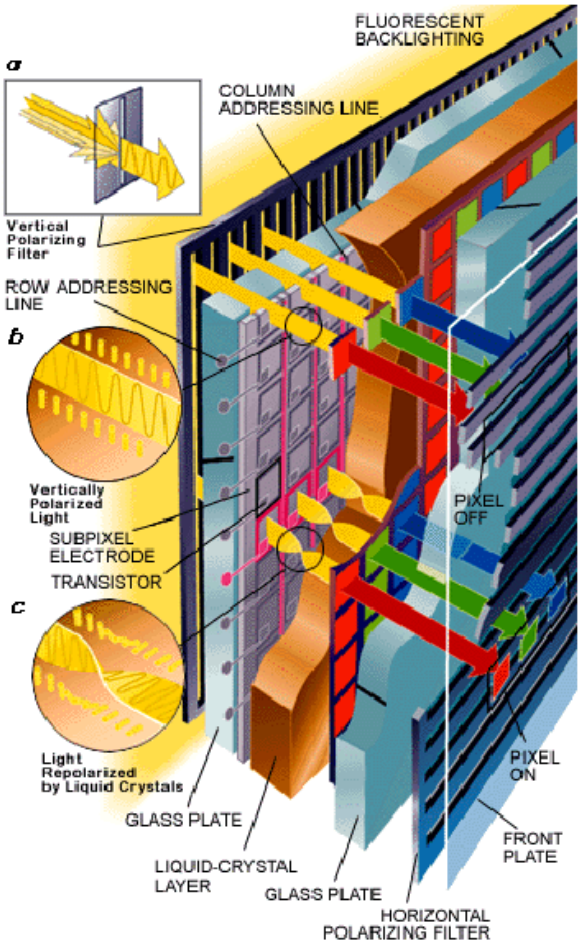
- Material Properties (birefringence)
- Liquid Crystal director
- Twisted Nematic LCs and their use with polarizers to make pixels

LIGHT BULBS

- Visible and IR/UV spectrum
- Spectral emission of incandescents, fluorescents, LEDs
- Efficiency of light sources

LCD DISPLAYS

- **Eye response**
  - Perception of color
- **Light Guide**
- **Passive/Active matrix displays**
- **Reflective LCD Displays**



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