

Course Information for

**Microelectronic Devices,
Electromagnetics,
Plasma Physics,
& Photonics**

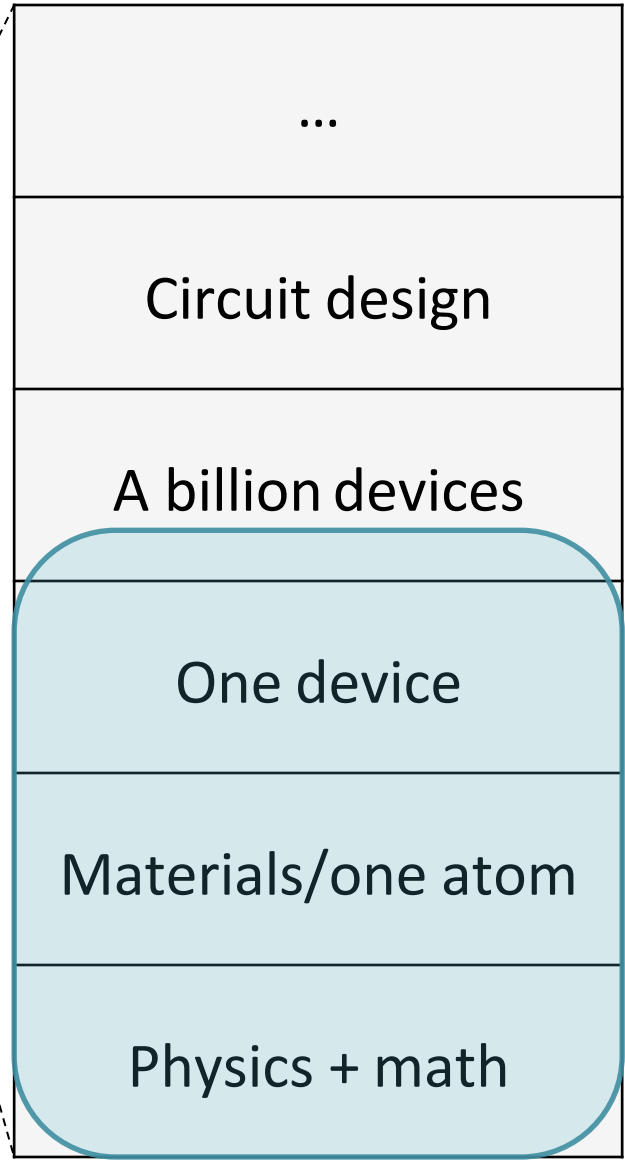
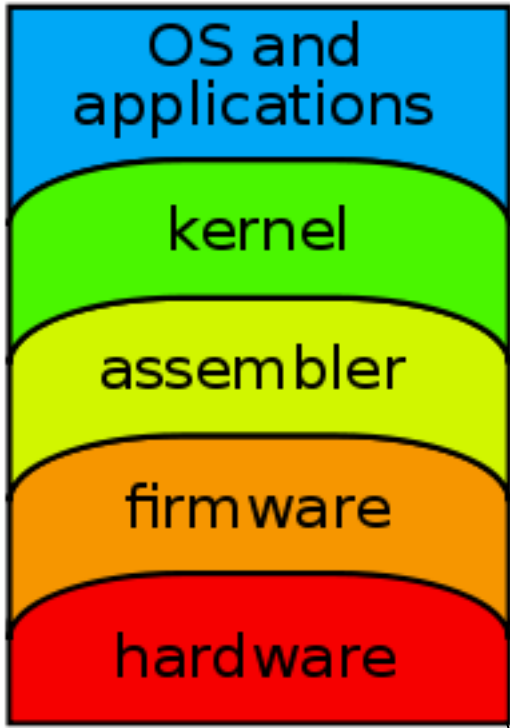
August 2019

Prof. Jamie Teherani

Electrical Engineering, Columbia University

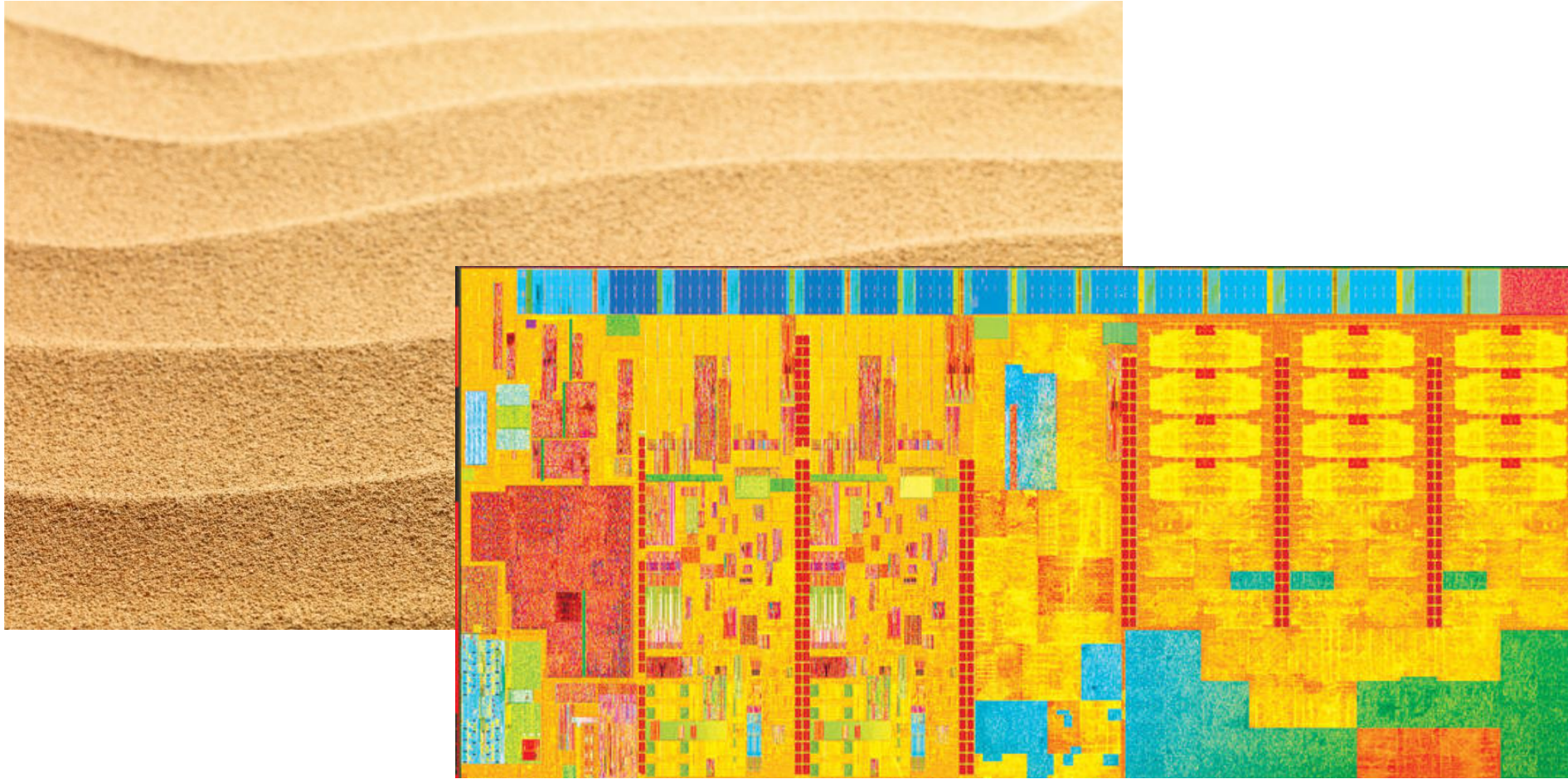
j.teherani@columbia.edu

Hierarchy of Technology

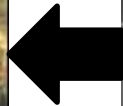
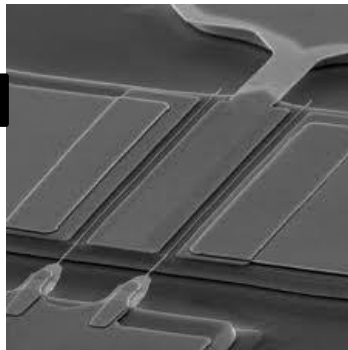
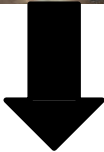


Realm of
Microelectronics,
Electromagnetics,
Plasma Physics,
& Photonics

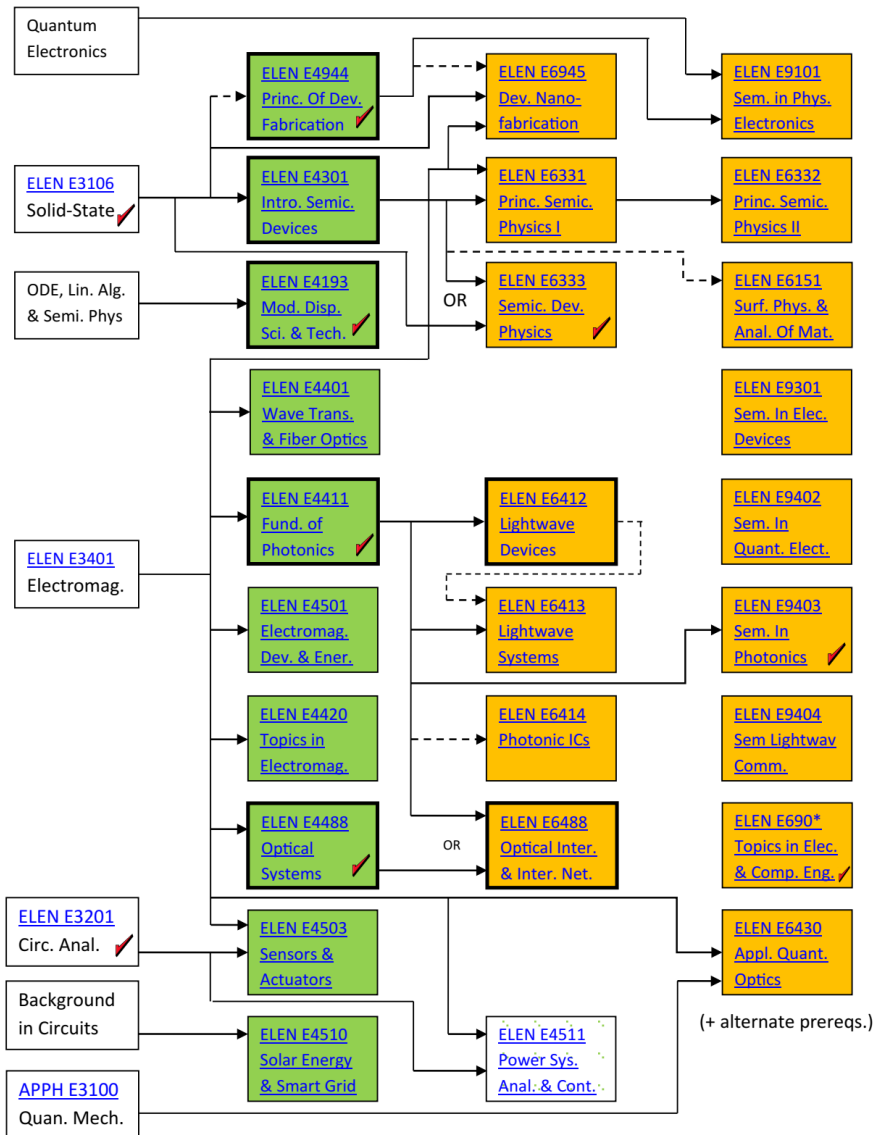
From Sand to Devices



Apple A11 (iPhone 8 + X)
Fabricated by TSMC 10 nm
4,300,000,000 (4.3B) transistors



INTEGRATED DEVICES & PHOTONICS
Senior/graduate & Advanced graduate courses in EE



Green = Senior/grad; Orange = Advanced graduate; Bold border = offered regularly;
Dotted lines = recommended preparation; Updated AUG 2019
Recent related topics courses:
ELEN E6903 Topic: *Nanoelectronic Device Simulations (Fall '19)*
ELEN E6905 Topic: *Computational Photonics & Quantum Electronics (Fall '17)*
ELEN E6906 Topic: *Low-Dimensional Nanoelectronics (Spring '15)*
ELEN E6907 Topic: *Emerging Nanoelectronic Devices (Fall '19, '13-'17)*
ELEN E9301 Topic: *Theory & Practice of Device Scaling (Spring '17)*

Links to Course Offerings

[2017-2018 SEAS Course Bulletin](#)
(PDF of all engineering classes)

[Directory of Classes](#)
(search for classes by name, time, etc.)

Online Course Bulletins – current!
(class listings, descriptions, & prerequisites)

[ELEN—Electrical Engineering](#)

[APPH, APAM—Applied Physics/Applied Math](#)

[BMEN—Biomedical Engineering](#)

[COMS—Computer Science](#)

[MSAE—Materials Science & Engineering](#)

[MECE—Mechanical Engineering](#)

Microelectronic devices

Topics:

- Fabricating devices starting from raw materials
- Modeling, and understanding their operation (especially the physics of operation)
- Design of superior devices
- Operation at the single device level (circuit design is at the multi-device level)

Useful for careers in silicon microelectronics, MEMS, device modeling, solar energy, and device/material fabrication

Device physics is foundational for circuit design

Microelectronics — Fall

ELEN 4944 Principles of Microfabrication

ELEN 6333 Semiconductor Device Physics

ELEN 6903 Nanoelectronic Device Simulations

ELEN 6907 Emerging Nanoelectronic Devices

EEBM 6901 Devices and Analysis for Neural Circuits

MECE 4212 Microelectromechanical Systems

Courses in solid state physics/material science:

APPH 4100 Quantum Physics of Matter

APPH 6081 Solid State Physics I (not offered Fall 2019)

CHAP 4120 Statistical Mechanics

MSAE 4206 Electronic and Magnetic Properties of Solids

Microelectronics — Spring

ELEN 6331 Principles of Semiconductor Physics

APPH 6082 Solid State Physics II

MECE 4212 Microelectromechanical Systems

MECE 4213 Bio-microelectromechanical Systems
(BioMEMS): Design, Fabrication and Analysis

+ more...

Optics and Electromagnetics

- Making devices that generate, measure, or manipulate light and radio waves
- Using them to do useful things (e.g. building high speed networks)
- Useful for many careers in science and engineering. Topics include networking, surface science, optoelectronics device fabrication, displays, data storage, and laser technology.
- Also relevant for optical and RF circuit design

Optics

Fall:

ELEN 4193 Modern Display Science and Technology

ELEN 4411 Fundamentals of Photonics

ELEN 4488 Optical Systems

ELEN 6413 Lightwave Systems (not offered Fall 2019)

APPH 4110 Modern Optics

Spring:

ELEN 6412 Lightwave Devices

ELEN 6488 Optical Interconnects +
Interconnection Networks

Electromagnetics

Fall:

ELEN 4411 Fundamentals of Photonics

APPH 4300 Applied Electrodynamics

BMEN 4430 Principles of Magnetic Resonance
imaging

Spring:

ELEN 4703 Wireless Communications

Plasma physics (APAM)

- How to understand, make, and control plasmas (overlaps with electromagnetism and other EE areas)
- Extensively used in some areas of lighting, fusion, material conversion, material analysis, plasma fusion, astrophysics, etc.

Fall:

APPH 6101 Plasma Physics I

Spring:

APPH 4301 Introduction To Plasma Physics (prereq for some courses in the area)

APPH 6102 Plasma Physics II

Other relevant classes

APPH 4130 Physics of Solar Energy

MECE 4210 Energy Infrastructure Planning

Classes in biomedical and nuclear physics

Final advice

- The devices/optics/electromag. offers a variety of choices for concentration or to enrich a program in another area (e.g. circuits)
- Assess your mastery of the prerequisites for each track you're interested in and make sure to take a course that's at the right level for you
- Be sure to keep courses in other related departments in mind when mapping out your schedule
- Your career goals will help guide your focus areas
- If you are interested in research, look for projects! Up to 6 units of project can be applied toward your degree.
- Think about what you will do over the summer and after you graduate — get research experience!