ECE3030 Course Syllabus

ECE3030

Physical Foundations of Computer Engineering (3-0-0-3)

CMPE Degree
This course is Required for the CMPE degree.

EE Degree
This course is Elective for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Mukhopadhyay,Saibal

Prerequisites
ECE 2020/2030 [min C] and ECE 2040 [min C]

Corequisites
None

Catalog Description
Basic principles governing the physical realization of computing systems and their relationship to characteristics such as performance, energy, and robustness. Implementation technologies.

Textbook(s)
Marilyn Wolf, *The Physics of Computing* (1st edition), Elsevier, 2016. ISBN 0128093811, ISBN 9780128093818 (required)

Course Outcomes
Upon successful completion of this course, students should be able to:

1. perform speed and energy analysis of devices and circuits used as digital logic elements.
2. derive the computational power of both finite (FSM) and infinite (Turing) models of computation.
3. derive and compute noise limits (thermal, coupling, etc.) in digital devices and interconnect.
4. apply speed/energy/reliability properties of CMOS to the design of simple CMOS digital circuits.
5. apply speed/energy/reliability properties to the design of at least one non-CMOS technology.

Student Outcomes
In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.

"LN" for "little to none" indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. (LN) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (LN) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (M) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

1. Introduction to a digital information processing system

2. Fundamental principles and requirements of representations
   a. distinguishability and conditional change of states
   b. physical implementation of a bit - Barrier Model and other

3. Physics of CMOS based Computation - Barrier Model
   a. Use of energy barrier to represent and modulate a bit
      * Relation to semiconductor physics
   b. Engineering energy barrier in practice
      * MOSFET and device physics
      * Switches as computing devices
   c. Physics of interconnected switches to process information
      * Relationship to RC circuit analysis
   d. Physics of data communications via signal propagation throu
      * Relationship to electromagnetism and Transmission lines
   e. Physical attributes of a computing system
      * Performance, Energy, and Robustness/Error
      * Relation to semiconductor physics, circuit theory, and
      * Interaction of performance, energy, and robustness
      * Understanding the physical limits CMOS circuits

4. Other computing systems and models
   a. Fundamentals of CMOS based analog computing
   b. Alternative computing models - e.g. concepts of quantum com