ECE3040 Course Syllabus

ECE3040

Microelectronic Circuits (4-0-0-4)

CMPE Degree
This course is Elective for the CMPE degree.

EE Degree
This course is Required for the EE degree.

Lab Hours
0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator
Ralph,Stephen E

Prerequisites
See topical outline

Corequisites
None

Catalog Description
Basic concepts of microelectronic materials, devices and circuits.

Textbook(s)
Jaeger & Blalock, *Microelectronic Circuit Design* (5th edition), McGraw Hill, 2015. ISBN 9780073529608 (required)

Pierret, *Semiconductor Device Fundamentals*, Addison Wesley, 1996. ISBN 0201543931, ISBN 9780201543933 (required)

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

1. Compute carrier concentrations for semiconductor materials under a variety of conditions.
2. Compute conductivity and resistivity of semiconductor materials under a variety of conditions.
3. Compute terminal voltage and current characteristics for pn junction diodes under a variety of conditions.
4. Compute terminal voltage and current characteristics for bipolar transistors under a variety of conditions.
5. Compute terminal voltage and current characteristics for MOS transistors under a variety of conditions.
6. Compute terminal voltage and current characteristics for ideal operational amplifiers under a variety of conditions.
7. Analyze the DC performance of single-stage analog amplifiers containing these circuit elements.

8. Analyze the AC performance of single-stage analog amplifiers containing these circuit elements.
9. Analyze the DC performance of simple digital circuits (e.g., inverters and logic gates) containing these circuit elements.

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

ECE 3043* and ECE 2031/20X2 and (ECE 2035 or ECE 2036) and ECE 2040

Introduction: Course mechanics, Silicon, Example of silicon devices
Basic Semiconductor Physics: Hydrogen Atom (briefly), Periodic pote
Lattices Crystals and Dopants: Metals, Semiconductors and Insulator
Fabrication, DOS, Fermi Statistics: Semiconductor Alloys, Carrier d
Carrier Statistics: Temperature and doping effects, Extrinsic semic
Carrier Transport: Drift velocity, Effective mass, Mobility and Sa
Carrier Transport, Diffusion Fick?s Law, Total current, Einstein Re
Optical Properties: Absorption, Recombination and Generation
Return to Equilibrium: Low level injection, Quasi Fermi Levels, Dir
Equations of State: Continuity equation, Minority carrier diffusion
PN Junctions: Current Flow in PN junctions, Diffusion w forward/rev
Real PN Junctions: Capacitance, Recombination/generation, Avalanche
Circuit Models: Large signal models, Small Signal Models, Small sig
Photonic devices: Absorption, Photodiodes, Solar Cells, LEDs, Laser
Intro to Transistors: Structure and nomenclature, Currents/band dia
BJT quantitative derivation: Terminal currents, Ebers Moll model, A
Small Signal Circuit Model: Small Signal analysis, General 2-port m
MOS Capacitors: Energy levels and flatband, Static and Biased band
MOS Transistor: Qualitative description, Triode regime, Pinch-off a
MOS Transistors: Deviations from ideal, Enhancement and depletion m
DC Aspects of Amplifiers: Bias networks for MOSFETs, Current mirror

Single Transistor Amplifiers: Inverting amplifiers, CS and CE, Foll
Multi-stage Amplifiers: Configurations, Cascaded stages, DC equival