CMP1202 Electronics II

Period per Week			Contact Hour per Semester	Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	30	00	60	100	60	40	4

Rationale

This is a continuation of CMP1101: Electronics I.

Objectives

The course aims to provide the student with:

- An understanding of how complex devices such as field-effect transistors are modelled and how the models are used in the design and analysis of useful circuits.
- The capability to design and construct circuits, take measurements of circuit behavior and performance, compare with predicted circuit models and explain discrepancies.

Course Content

1. Bipolar Transistors and Logic families

- npn and pnp transistor operation
- i-v characteristics
- Regions of operation, models, and limitation
- Transfer characteristic of BJT with load resistor
- Biasing for logic and amplifier applications
- Logic level definitions
- The differential pair as a current switch
- Transistor-transistor logic – inverters, NAND, other functions
- Emitter-coupled logic – OR/NOR gate, other functions
- Low voltage bipolar logic families

2. Design Parameters and Issues

- Switching energy, power-delay product comparison
- Propagation delay, rise time, fall time
- Fan-in and fan-out
- Power dissipation, noise margin
- Power supply distribution
- Sources of signal coupling and degradation
- Transmission line effects
- passive, active, dc and ac termination
- Element tolerances
- Worst-case analysis of circuits
- Monte Carlo analysis
- Monte Carlo analysis in SPICE
- Six-sigma design

3. Storage Elements

- Latches
- Flip-flops

- Static RAM cells
- Dynamic RAM cells
- Sense amplifiers

4. Interfacing Logic Families and Standard Buses

- Terminal characteristics of various logic families
- Standard interface characteristics
- Level translations: TTL/CMOS, TTL/ECL, CMOS/ECL
- Single-ended to differential and differential to single-ended conversion
- Transmission line characteristics, reflections
- Bus termination: Passive, active, dc, ac
- 4-20 mA current interfaces
- RS-XXX buses; IEEE-XXXX buses
- Low-level differential signaling
- RAMBUS
- DDR

5. Circuit Modeling and Simulation

- DC analysis
- AC analysis
- Transient analysis
- Simulation control options
- Built-in solid-state device models
- Device parameter control
- Libraries
- Mixed-mode simulation

Learning Outcomes

- Indicate the areas of use of bipolar logic families; and demonstrate the ability to implement a range of logic functions using bipolar logic.
- Incorporate design strategies in power distributions and transmission; and apply methods to minimize noise and other signal degradations.
- Compare and contrast the properties of different kinds of storage element to serve different purposes; and select (with reasons) appropriate kinds of storage elements for use in a range of possible devices.
- Explain the practical difficulties resulting from the distribution of signals; and explain ways to overcome these difficulties when interfacing different logic families.
- Explain with justification the ideal properties of operational amplifiers; design various amplifier structures and filters with ideal op-amps; understand characteristics of non-ideal op-amps; and design simple circuits with them.
- Explain with justification the benefits and the drawbacks associated with the simulation of circuits; identify aspects of circuits that are not readily amenable to simulation; and simulate a range of possible circuits using a suitable software package.

Recommended and Reference Books

[1] Agarwal, Anant, and Jeffrey H. Lang. **Foundations of Analog and Digital Electronic Circuits**. San Mateo, CA: Morgan Kaufmann Publishers, Elsevier, July 2005. ISBN: 9781558607354.

[2] Earl D. Gates, *Introduction to Electronics*, 4th ed., Thomson, 2004

[3] D. C. Green, *Electronics 4*, 3rd ed., Longman, 1995