

Course Description

3017 - Digital Electronics

Course Code:	3017
Course Title	Digital Electronics
Academic Year:	2007
Semester:	1
Lecturer:	Dr Said Al-Sarawi
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Aims:

The aims of the course are to:

- Provide practice in the design and development of a moderately complex digital circuits;
- Develop the students' knowledge of digital system design in the areas of finite state machine design, high-performance arithmetic circuitry, datapath design and arithmetic logic units;
- Give students a “systems perspective” on digital microelectronic circuits;
- Introduce the manufacturing techniques used in integrated circuit fabrication to illustrate the opportunities and constraints offered by digital microelectronic technology.

Outcomes:

After passing this course, students will be familiar with methods for specifying, and synthesising moderately complex logic circuits. Students will also be familiar with issues involved in:

- Designing and testing digital microelectronic circuits using hardware description languages such as VHDL or Verilog.
- Selecting an appropriate microelectronic technology; with respect to cost/volume/time-to-market and performance issues.
- Design techniques for optimising microelectronic circuit implementations.

Previous studies:

A summary of previous knowledge assumed for the subject is:

- Boolean variables, operators and algebra.
- Number systems.
- Common combinational logic functions.

- Synchronous sequential logic.
- Introduction to state machine.

Delivery methods:

The delivery method is composed of 26 lectures, 4 tutorials and 3 computer laboratories tutorials. The lab tutorials comprise PC-based VHDL programming.

Assessment:

- Written exam (70%),
- Project-Based Learning on using FPGA in Digital Design (20%), and
- Two test (10%).

Recommended/Reference Texts:

- Rabaey, J.M. "Digital Integrated Circuits," 2nd Edition, Prentice-Hall, 1996. Highly recommended.
- Katz, R.H. "Contemporary Logic Design," Benjamin/Cummins. Highly recommended.
- Bhasker, J. "A VHDL Primer," 3rd Edition Prentice-Hall, 1999. Recommended. Reference.
- Weste, N. and Eshraghian, K. "Principles of CMOS VLSI design", 2nd Edition. Addison Wesley. Reference

Course Outline - Digital Electronics

- Integrated Circuits (1 Lecture)
- Fabrication process of MOS devices
- Overview of implementation technologies and economics
- CMOS Logic Gates (4 Lectures)
- CMOS inverter characteristics, delay models, transistor sizing
- CMOS complex gates and delay reduction techniques
- Adder CMOS implementation
- Sources of power consumption
- Datapath Design and Arithmetic Logic Units (6 Lectures)
- Adders – ripple carry, mirror type, linear and square root carry select, linear and square carry bypass, carry look-ahead, Manchester carry and design trade-offs. (4 L)
- Multipliers – definition, array and carry-save structures, basic concept of Wallace tree structure. (2 L)
- Hardware Description Language – VHDL (6 Lectures)
- FPGA – architecture, design flow, modelling and coding approaches. (5 L)
- Project specification software description (1 L)
- Memory Design (2 Lectures)
- SRAM, 3T DRAM, 1T DRAM read-write (2 L)
- State Machine Design – Synchronous and Asynchronous Systems (6 Lectures)
- Concept of the state machine and basic design approach (1.5 L)
- Alternative state machine representations (1 L)
- Moore and Mealy machines (1 L)
- State machines optimisation (1.5 L)
- Case study (1 L)

Graduate Attributes

- GA1 An advanced level of knowledge and understanding of the theory and practice of Electrical and Electronic, Computer Systems or IT&T Engineering and the fundamentals of science and mathematics that underpin these disciplines.
- GA2 A commitment to maintain an advanced level of knowledge throughout a lifetime of engineering practice and the skills to do so.
- GA3 The ability to apply knowledge in a systematic and creative fashion to the solution of practical problems.
- GA4 A commitment to the ethical practice of engineering and the ability to practice in a responsible manner that is sensitive to social, cultural, global, legal, professional and environmental issues.
- GA5 Interpersonal and communication skills for effective interaction with colleagues and the wider community.
- GA6 An ability to work effectively both independently and cooperatively as a leader, manager or team member with multi-disciplinary or multi-cultural teams.
- GA7 An ability to identify, formalise, model and analyse problems.
- GA8 The capacity to design, optimise, implement, test and evaluate solutions.
- GA9 An ability to plan, manage and implement solutions that balance considerations of economy, quality, timeliness and reliability as well as social, legal and environmental issues.
- GA10 Personal attributes including: perseverance in the face of difficulties; initiative in identifying problems or opportunities; resourcefulness in seeking solutions; and a capacity for critical thought.
- GA11 Skills in the use of advanced technology, including an ability to build software to study and solve a range of problems.
- GA12 A commitment to the highest standards of professional endeavour and the ability to take a leadership role in the community.
- GA13 An ability to utilise a systems approach to design and operational performance.
- GA14 Understanding of the principles of sustainable design and development.

These programs also foster the graduate attributes of the University of Adelaide and the Institution of Engineers Australia. These should be read in conjunction with the list above.