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CEG 3320-01: Digital System Design

Travis E. Doom
Wright State University - Main Campus, travis.doom@wright.edu

WRIGHT STATE UNIVERSITY
Wright State University
College of Engineering and Computer Science
Department of Computer Science and Engineering

Digital System Design

CEG 3320

Professor: Travis E. Doom, Ph.D.
Professor's Office: 331 Russ Engineering Center
Email: (Preferred contact) travis.doom@wright.edu
Office Phone: (937) 775-5105

Laboratory: 357 Russ Engineering Center

Course Description: Basics of Digital Computer Hardware and Design. Topics include switching algebra and switching functions, logic design of combinational and sequential circuits, storage elements, register-level design, and instrumentation. 3 hours lecture, 1 credit hour lab.

Prerequisites: College-level familiarity with programming languges (CS 1180 Computer Science I or CS 1160 Intro to Computer Prog or CEG 2170 Intro to C Prog) AND College-level mathematical readiness (MTH 1280 College Algebra OR MTH 1340 Precalculus OR WSU Math Level MPL 05).

Objectives: This course has two primary objectives. The first is content-based. We hope to teach students the fundamental principles of design for sequential digital devices. The second objective is skill-based. Students will exercise their ability to apply these principles in practical application though laboratory projects. At the end of this course, each passing student should be able to:

- **CE-DIG1 Switching theory**
- 1. Work with binary number systems and arithmetic.
- 2. Derive and manipulate switching functions that form the basis of digital circuits.
- 3. Reduce switching functions to simplify circuits used to realize them.

- **CE-DIG2 Combinational logic circuits**
- 1. Realize switching functions with networks of logic gates.

- 2. Explain and apply fundamental characteristics of relevant electronic technologies, such as propagation delay, fan-in, fan-out, and power dissipation and noise margin.

- **CE-DIG3 Modular design of combinational circuits**
- 1. Analyze and explain uses of small- and medium-scale logic functions as building blocks.
- 2. Analyze and design combinational logic networks in a hierarchical, modular approach, using standard and custom logic functions.

- **CE-DIG4 Memory elements**
- 1. Design and describe the operation of basic memory elements.
- 2. Analyze circuits containing basic memory elements.
- 3. Apply the concepts of basic timing issues, including clocking, timing constraints, and propagation delays during the design process.

- **CE-DIG5 Sequential logic circuits**
- 1. Analyze the behavior of synchronous machines.
- 2. Synthesize synchronous sequential machines.

- **CE-DIG6 Digital systems design**
- 1. Apply digital system design principles and descriptive techniques.
- 2. Analyze and design functional building blocks and control and timing concepts of digital systems.
- 3. Develop a complex digital system design in a hierarchical fashion using top-down and bottom-up design approaches.
- 4. Utilize programmable devices such as FPGAs and PLDs to implement digital system designs.

- **CE-DIG7 Modeling and simulation**
- 1. Model and simulate a digital system using schematic diagrams.
- 2. Understand timing issues in digital systems and know how to study these via digital circuit simulation.

Intensive writing: This course requires the maintaince of a laboratory/engineering notebook. In this courses, students are expected to produce writing that:

- Demonstrates their understanding of course content,
- Is appropriate for the audience and purpose of a particular writing task,
- Demonstrates the degree of mastery of disciplinary writing conventions appropriate to the course (including documentation conventions), and
- Shows competency in standard edited American English.

Textbook: Every student should have access to *some* reference textbook or material to supplement the lecture instruction. As taught, this course does not *require* any specific textbook. Students are free to use any contemporary textbook or on-line resource to supplement the material discussed in lecture and laboratory. Several copies of contemporary textbooks are available in the laboratory for student use. Chapter/sections for lecture material will be provided only for the most current edition of the *recommended* textbook.
Recommened: Vahid, Frank. "Digital Design", any edition, John Wiley and Sons.
Reference: Mano, Morris and Kime, Charles. "Logic and Computer Design Fundamentals", any edition, New Jersey: Prentice-Hall.

Grading: A student's demonstration of their ability to discuss issues, solve problems, and demonstrate mastery of digital design will be the underlying metric for the determination of a student's overall grade in this course. Students will be provided the opportunity to demonstrate their mastery through examinations and laboratory projects. Grades will be assigned on a standard A/90%, B/80%, C/70%, D/60%, F/60%- scale. Clustering of grades may cause the thresholds to be lowered; they will not be raised. The instructor reserves the right to fail any student who does not a student attain both a passing grade (70%+) in the laboratory and at least a grade of 50% on the final. The overall course grade will be the weighted sum of the three grades:

120 pts. (~40%) Laboratory Projects	Labs #1-12: @ 10 pts.
100 pts. (~30%) 1/2-Hour Examinations	5 (of 6) @ 20 pts.
100 pts. (~30%) Final Examination	100 pts.
320 pts. (100%) Total	

Retakes: Laboratory grades from previous quarters are never used in grade calculation. Students who take this course a second time are expected to retake the laboratory. Students who are retaking the course but have masted the laboratory component (80%+ in all labs) may request permission from the instructor to waive the laboratory. If this permission is granted, then overall course grade will be determined on the basis of all six quizzes (no drop) and the final (220 point total).

Absences: Class attendance will not be a direct factor in your grade but may strongly effect the quality of your education. Students are expected to attend every class. Things may make less sense to students that do not attend class or arrive late. Students who miss class are responsible for the material or announcements presented. Any extenuating circumstances which impact on your participation in the course should be discussed with the course instructor as soon as those circumstances are known. There

are no make-ups for half-hour examinations. Make-ups for laboratory may be arranged if a student's absence is caused by documented illness or personal emergency. It is the student's responsibility to provide a written explanation (including supporting evidence) to the instructor in a timely manner. Students registering after the term begins are responsible for all missed assignments and cannot expect that due dates will be altered due to their late enrollment.

Laboratory Projects: The laboratory projects are designed to help you learn the course concepts and are the primary course "homework". The laboratory projects may be very time consuming if you are not comfortable with the necessary concepts before beginning the project. Most laboratories have a component that can be accomplished outside/after the scheduled laboratory period. This work must be turned into the TA two days prior to the student's next scheduled laboratory period. Students should be prepared to demonstrate and answer questions about their projects and design decesions. **This is a writing-intensive course**: All work, from initial design to final implementation must be included in each student's lab book.
Students must attend their scheduled lab section every week. This is the only time that a lab instructor is guaranteed to be present to sign-off lab demonstrations and to explain concepts necessary for the next lab project. Some labs require that students have access to the laboratory tools. Student ID cards will permit access to the Lab in 357 RC at any time in which the lab is not in use for a scheduled course. Students may also work on computer systems for most projects. Whenever possible, free software/tools will be made available for student download and use at home.

Lab Late Penalty: Marks will be deducted for projects submitted late on a per day basis. No points will be awarded for projects that are more than one week late. Corrupt files or other computer problems will not be considered a sufficient excuse to extend this deadline. It is your responsibility to back-up your work. Students are expected to save work to multiple storage media to aid in the recovery of corrupt files.

Examinations: Six roughly half-hour examinations and one final examination will be administered as announced throughout the term. These examinations are "extended homeworks" and are designed to encourage students to cover course material at a steady pace and to provide feedback throughout the quarter. Students should be able to discuss course concepts in detail and be able to demonstrate their mastery by applying these concepts.
Midterm examinations will occur at the normally scheduled class time and location unless announced otherwise in class. The final examination is cumulative and will take place during the university scheduled time period in the normally scheduled class location unless announced otherwise in class.

Make-up/Rescheduling examinations: There are no make-up examinations for half-hour examinations. However, each student is allowed to drop one make-up examination for any reason. Thus, if travel/sickness/emergency causes you to miss an examination, you do not need to inform the instructor. A missed examination will simply be treated as a '0' for the purposes of dropping the lowest examination. Rescheduling of a final is allowed for documented emergency/need, but please contact the instructor as soon as is possible.

Use of materials/notes on examinations: Examinations are closed-book. On half-hour examinations, undergraduate students may use one sheet of 8.5 x 11" of hand-crafted notes (double-sided) as reference. Making these notes is part of the learning process. Thus, these notes must be constructed by the student. The notes can be handwritten or typed, but must be crafted by the student. Simply copying of the instructors lecture notes, the textbook, or other students' notes is prohibited. Undergraduate students may use six pages of notes on the final.

Course Assignments: The instructor will provide a number of opportunities for students to develop their mastery of the subject throughout the course through ungraded course assignments. Students are encouraged to work on homework problems in collaborative groups on this ungraded materials. Students are all encouraged to work on problems from the textbook and other sources to develop their mastery. Each student is expected to keep a portfolio of this ungraded course material. This portfolio should consist of a 3-ring binder containing returned examinations, lecture and textbook notes, textbook problems corresponding the the assigned readings, documented excuses for absences, and other course material. Your *course portfolio* (in conjunction with your lab notebook) is the physical representation of your course effort and may be a factor in determining "border-line" grades; take care not to misplace it!

Academic Integrity: Student-teacher relationships are built on trust. For example, students must trust that instructors have made appropriate decisions about the structure and content of the courses that they teach, and instructors must trust that the assignments which students turn in are the product of their own efforts. Acts which undermine this trust undermine the educational process. It is the policy of Wright State University to uphold and support standards of personal honesty and integrity for all students consistent with the goals of a community of scholars and students seeking knowledge and truth. Furthermore, it is the policy of the university to enforce these standards. The following recommendations are made for students:

1. Be honest at all times.
2. Act fairly towards others. For example, do not seek an unfair advantage over others by cheating with or by looking at other individual's work during examinations or laboratory assignments.
3. Take group as well as individual responsibility for honorable behavior. Collectively, as well as individually, make every effort to prevent and avoid academic misconduct, and reports acts of misconduct that you witness.
4. Know the policy -- ignorance is no defense. Read the policy contained in the student handbook. If you have any questions regarding academic misconduct, contact your instructor.

Students are encouraged to get together in small study groups to discuss the course topics and homework problems. Small group discussion and collaboration is a vital aid to mastering the concepts presented in this course. Modern designs are rarely the work of a single engineer! Being able to communicate and work in teams is a necessary skill for any computer engineer. However, **students must work on all graded course assignments and examinations on an *individual* basis.**

Academic conduct for Laboratory Assignments: Students may discuss "general concepts" of laboratories assignments with each other, but may not, under any circumstances, work with anyone on their actual implementation. If you work with other student on "general concepts" be certain to acknowledge the collaboration and its extent in the assignment. Unacknowledged collaboration will be considered dishonest. Sharing (or copying) schematics or datafiles (including work from previous quarters) is strictly disallowed. If the same work is turned in by two or more students I will consider all students involved equally culpable. *You are responsible for ensuring that other students do not have access to your work* - do not give another student access to your account, do not leave printouts in the recycling bin, pick up your printouts promptly, do not leave your workstation unattended, etc. If you suspect that your work has been compromised notify your instructor immediately.

Academic conduct for Examinations: The academic code demands that no student should have an unfair advantage over any other student during examinations. Thus, it is strictly forbidden for any student to refer to information from previous offerings of this course unless this information is provided by the instructor to all students fairly. Thus, the use of test banks of previous quizzes, access to other students' lab books, or other use of prior offering course material is strictly forbidden.

Additional Information: Copies of the presentation used in lecture, supplementary textbooks, and additional course-related information are available in the laboratory for

student reference. Information regarding assigned course readings, homework, and syllabus updates will be available via course web page. Students are responsible for reading this material on a weekly basis. Students that do not have active computer accounts or are otherwise unable to access the course WWW page should contact me.

Additional Needs: Students with disabilities or any additional needs are encouraged to set up an appointment at their convenience to discuss any classroom accommodations that may be necessary.

Dr. Travis Doom, travis.doom@wright.edu.