Advanced Integrated Circuit Design
DFTG 2433
Semester and Year

Instructor —

Synonym —

Section Number —

Class Hours —

Office —

Office Hours —

Phone —

Email —

Please contact me if you wish to meet with me outside of regular office hours.

COURSE RATIONALE

This course builds on the knowledge and skills acquired in Dftg 2413 regarding the layout and design of integrated circuits. Topics will include digital and analog designs. On digital layout, emphasis will be placed upon area optimization while analog layout will incorporate precision techniques including translational placement, device matching, common centroid and cross-coupled common centroid.

COURSE DESCRIPTION

An advanced course in the layout and design of integrated circuits. CMOS technology will be explored further equipping students with a deeper understanding of the relationship between the electrical and physical aspects of integrated circuits. Studies shall expand to include the different needs of digital and analog designs. With digital layout, emphasis will be placed upon area optimization while analog layout shall incorporate precision techniques including translational placement, device matching, common centroid and cross-coupled common centroid. Students will continue their training in Cadence Virtuoso including the advanced functionality of Cadence Virtuoso XL. Instruction in DRC and LVS verification shall progress to debugging strategies. May be taken concurrently with CETT 1425.

PREREQUISITES

DFTG 2413 Basic Integrated Circuit Design

REQUIRED TEXTS/MATERIALS

Textbook

IC Layout Basics: A Practical Guide, by Christopher Saint and Judy Saint, McGraw-Hill Professional

STUDENT LEARNING OUTCOMES

Course-Level Student Learning Outcomes

Upon successful completion of the course, students will be able to:

- Perform the foundational skills acquired in IC Layout I as well as improve speed and accuracy of layout
- Translate design schematics into layout architecture
- Explain the CMOS fabrication process
- Explain the function of the transistor & the illustration of the CMOS cross-section
- Construct cells utilizing hierarchy & understand the capabilities of the layout tool
- Explain how resistance and capacitance of layout shapes influences circuit performance & methods to reduce negative effects
- Utilize CAD tools to design and layout memory cells including edge and cap cells
- Utilize CAD tools to design and layout analog devices using circuit balancing techniques
- Utilize CAD tools to design and layout datapaths

PROGRAM-LEVEL STUDENT LEARNING OUTCOMES

At the completion of the AAS degree –Electronics Graphics Specialization - the student will be able to:

E1. Utilize CAD software to plan and prepare technical graphics and documentation appropriate to the Electrical/Electronic Engineering industry.

E2. Utilize CAD software to translate schematics, logic diagrams, and other technical graphics into the physical layout of Integrated Circuits and Printed Circuits.

E3. Employ CAD-based verification tools and techniques to debug Integrated Circuit layouts.

I1. Utilize CAD software to plan and prepare documents and technical graphics appropriate to a range of design, manufacturing, and construction industries.

At the completion of the IC Layout and Design Certificate the student will be able to:

E1. Utilize CAD software to plan and prepare technical graphics and documentation appropriate to the Electrical/Electronic Engineering industry.

E2. Utilize CAD software to translate schematics, logic diagrams, and other technical graphics into the physical layout of Integrated Circuits and Printed Circuits.

E3. Employ CAD-based verification tools and techniques to debug Integrated Circuit layouts.

SCANS COMPETENCIES

ARCHITECTURAL & ENGINEERING CAD SCANS FIVE COMPETENCIES

	Resources					Interpersonal						Information						Systems			Technology	
Courses	C1 Allocates Time	C2 Allocates Money	C3 Allocates Material	C4 Allocates Human Resources	C5 Participates as a Member of a Team	C6 Teaches Others	C7 Serves Clients/Customers	C8 Exercises Leadership	C9 Negotiates to Arrive at a Decision	C10 Works with Cultural Diversity	C11 Acquires & Evaluates Information	C12 Organizes & Maintain Information	C13 Interprets & Communicates Information	C14 Uses Computers to Process Information	C15 Understands Systems	C16 Monitors & Corrects Performance	C17 Improves & Designs Systems	C18 Selects Technology	C19 Applies Technology to Task	C20 Maintains & Troubleshoots Technology
ARCE 1452	✓		✓								✓	✓	✓	✓	✓	✓			✓	✓
DFTG 1405	✓				✓						✓	✓	✓	✓		✓		✓	✓	
DFTG 1413	✓					✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 1417	✓										✓	✓	✓	✓	✓				✓	✓
DFTG 1433	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 1445	✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 1458	✓										✓	✓	✓	✓	✓	✓	✓	✓		
DFTG 1475	✓		✓		✓		✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	
DFTG 1491*	✓							✓			✓	✓	✓	✓		✓	✓	✓	✓	
DFTG 1493	✓							✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 1494	✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 1495	✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 2400	✓					✓					✓	✓	✓	✓	✓	✓	✓		✓	✓
DFTG 2402	✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 2405	✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 2412	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2419	✓											✓	✓	✓	✓				✓	
DFTG 2421	✓					✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2427	✓					✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2428	✓										✓	✓	✓	✓	✓	✓			✓	✓
DFTG 2430	✓							✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2431	✓										✓	✓	✓	✓	✓				✓	✓
DFTG 2432	✓										✓	✓	✓	✓	✓	✓	✓		✓	✓
DFTG 2436	✓					✓					✓	✓	✓	✓	✓	✓	✓		✓	✓
DFTG 2440	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2470	✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 2471	✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	
DFTG 2473	✓					✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2474	✓										✓	✓	✓	✓	✓	✓			✓	✓
DFTG 2475	✓					✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2476	✓					✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2477	✓			✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MCHN 1419	✓				✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
ENGLISH																				
MATH																				
Oral Communication																				
Arts & Humanities																				
Social Behavior & Science																				

* = Capstone

ARCHITECTURAL & ENGINEERING CAD SCANS COMPETENCIES
FOUNDATION SKILLS

	Basic Skills					Thinking Skills							Personal Qualities				
Courses	*Reading*	*Writing*	*Arithmetic/Mathematics*	*Listening*	*Speaking*	*Creative Thinking*	*Decision Making*	*Problem Solving*	*Visualizing*	*Knowing How to Learn*	*Reasoning*	*Responsibility*	*Self-Esteem*	*Sociability*	*Self-Management*	*Integrity/Honesty*
ARCE 1452	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
DFTG 1405	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1413	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1417	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓			✓	✓
DFTG 1433	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1445	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1458	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1475	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1491*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1493	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 1494	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
DFTG 1495	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
DFTG 2400	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
DFTG 2402	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
DFTG 2405	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
DFTG 2412	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2419	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2421	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 2427	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 2428	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓
DFTG 2430	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 2431	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓
DFTG 2432	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2436	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2440	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DFTG 2470	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
DFTG 2471	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
DFTG 2473	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 2474	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓
DFTG 2475	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 2476	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
DFTG 2477	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MCHN 1419	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ENGLISH																
MATH																
Oral Communication																
Arts & Humanities																
Social Behavior & Science																

* = Capstone

COURSE EVALUATION/GRADING SCHEME

Grades will be determined as follows:

- Daily Work 50% of final grade
- Mid-Term Exam 25% of final grade
- Final Exam 25% of final grade

Daily Work shall consist of warm-ups, drawing assignments, questions and possible quizzes. Grades will reflect the quality of work performed within the assigned time period.

INSTRUCTIONAL METHODOLOGY

This course is taught in the classroom in a lecture/laboratory format. The lecture will generally introduce concepts and skills, which will then be developed and applied in the laboratory.

OPEN LABS

Hours for the open lab will coincide with the tutoring schedule which will be posted during the first week or two of the semester. **You may not be able to complete all the assignments in class**, so the open lab is one of your best opportunities to get help in finishing the lab exercises.

COURSE OUTLINE/CALENDAR

(Note: Schedule subject to change depending on pace of course)

Class 1

Introduce Course

Class 2

Introduce Integrated Circuits and questions

Class 3

Review IC I

Introduce Design Rules

Project: NOR layout

Class 4

Introduce Metal Connectivity and DIVA LVS

Project: Metal Connections layout

Class 5

Introduce Hierarchical Design and Virtuoso XL

Project: Hier3 layout

Class 6

Continue Hier3 layout

Class 7

Introduce Memory Design

Project: SRAM layout

Class 8

Continue SRAM layout

Class 9

Continue SRAM layout

Class 10

Introduce Analog Design, Translational Layout and Resistors

Project: Translat layout

Class 11

Introduce Common Centroid for Transistors

Project: Centroid layout

Class 12

Continue Centroid layout

Class 13

Introduce Common Centroid for Capacitors

Project: Cap Array layout

Class 14

Review for Mid-Term Exam

Continue Cap Array layout

Class 15

Mid-Term Exam

Class 16

Introduce Datapath Design

Project: Datapath Floorplan

Class 17

Continue Datapath Floorplan

Class 18

Project: Datapath Buffer layout

Class 19

Project: Datapath Mux layout

Class 20

Continue Datapath Mux layout

Class 21

Project: Datapath Latch layout

Class 22

Continue Datapath Latch layout

Class 23

Project: Datapath Halfadder layout

Class 24

Continue Datapath Halfadder layout

Class 25

Project: Datapath Adder layout

Class 26

Continue Datapath Adder layout

Class 27

Project: Datapath Bit and Top layouts

Class 28

Review for Final Exam

Continue Datapath

Class 29

Final Exam

COURSE/DEPARTMENTAL POLICIES

Attendance/Class Participation
Students accruing more than two (2) UNEXCUSED absences may be withdrawn from the course at the instructor's discretion. Students may make-up absences by attending other classes. It is the student's responsibility to inform instructor when circumstances prevent him/her from attending class. An instructor may lower a student’s final grade

for a course due to excessive absences. **Attendance at the Midterm and Final Portfolio Reviews are mandatory—students who do not attend these reviews may be dropped from the course.**

Cell Phones and Electronic Devices
To avoid disturbing or distracting others during class or open lab times, students are requested to conduct personal communications of any sort outside of the classrooms. For this reason, the use of cell phones and other PDA's by students is prohibited inside A&E CAD classrooms (this includes placing or receiving phone calls, text messages and emails). When conducting personal communication in the hallways, please control the volume of your voice so as not to disturb students in nearby classrooms.

Withdrawal Policy
Course withdrawals may occur at any time after the official reporting date of a semester and up to the established deadline for withdrawals in each semester. The established deadline is listed in the course schedule and on the Web.

It is the responsibility of each student to ensure that his or her name is removed from the roll if he or she decides to withdraw from the class. The instructor does, however, reserve the right to drop a student should he or she feel it is necessary. If a student decides to withdraw, he or she should also verify that the withdrawal is submitted before the Final Withdrawal Date. The student is also strongly encouraged to retain their copy of the withdrawal form for their records.

Initiation of Withdrawals:
Withdrawals from a course result in a grade of "W" and may be affected through action taken by either the student, the course instructor, or the instructor's immediate supervisor in the instructor's absence. Students who wish to withdraw from specific courses should initiate withdrawal procedures with the Campus Admissions and Records Office prior to the published deadline for withdrawals. Students who are not withdrawn as of the established deadline will receive a performance grade (A, B, C, D, or F). Students must present a picture I.D. to withdraw from the course.

Students who enroll for the third or subsequent time in a course taken since Fall 2002, may be charged a higher tuition rate, for that course.

State law permits students to withdraw from no more than six courses during their entire undergraduate career at Texas public colleges or universities. With certain exceptions, all course withdrawals automatically count towards this limit. Details regarding this policy can be found in the ACC college catalog.

Incompletes
The grade of "I" (for Incomplete) may be given by an instructor for a course in which a student was unable to complete all of the objectives for the passing grade. A grade of "I" cannot be carried beyond the established date in the following semester or session. The completion date is determined by the instructor, but may not be later than two weeks

prior to the end of the semester. The Department Chair will approve a change from "I" to a performance grade (A, B, C, D, F) for the course prior to or at the deadline. Consideration should be given to course load and job and family obligations when carrying an "I" grade into a new semester for completion. Grades of "I" that are not resolved by the deadline will automatically be converted to a grade of "F." In extreme cases, permission may be granted to carry an "I" grade for longer than the following semester or session deadline; this must have the approval of the Dean.

Policy on Late or Missing Work
Instructors may impose a late penalty on work that is submitted after the assigned due date.

Statement on Scholastic Dishonesty
Representing the work of another person as your own work is considered scholastic dishonesty by the A&E CAD department. Academic work submitted by students shall be the result of their own thought, research or self-expression. For purposes of this rule, academic work is defined as, but not limited to tests and quizzes, whether taken electronically or on paper; projects, either individual or group; papers; classroom presentations; and homework. When students borrow ideas, wording or organization from another source, they shall reference that information in an appropriate manner.

Reproduction or transmission of A&E CAD Departmental Check Prints in any manner (including photography and scanning) is a violation of the A&E CAD department's Scholastic Dishonesty policy.

Sharing a drawing file of a class project with another student, or representing the file of another student as your own work, is a violation of the department's Scholastic Dishonesty policy.

Violation of this policy may result in, but is not limited to, the following: reduction of the grade on the project, a grade of zero being recorded for the project, the assignment being replaced with a different project with a reduced maximum grade, the reduction of the final course grade, and in the most extreme cases, withdrawal from the course. Students accused of scholastic dishonesty will be subject to the procedures outlined in the Policies and Procedures for Academic Dishonesty section of the ACC Student Handbook.

Student Rights and Responsibilities
Students at the college have the rights accorded by the U.S. Constitution to freedom of speech, peaceful assembly, petition, and association. These rights carry with them the responsibility to accord the same rights to others in the college community and not to interfere with or disrupt the educational process. Opportunity for students to examine and question pertinent data and assumptions of a given discipline, guided by the evidence of scholarly research, is appropriate in a learning environment. This concept is accompanied by an equally demanding concept of responsibility on the part of the

student. As willing partners in learning, students must comply with college rules and procedures.

Statement on Students with Disabilities
Each ACC campus offers support services for students with documented disabilities. Students with disabilities who need classroom, academic or other accommodations must request them through the Office for Students with Disabilities (OSD). Students are encouraged to request accommodations when they register for courses or at least three weeks before the start of the semester, otherwise the provision of accommodations may be delayed.

Students who have received approval for accommodations from OSD for this course must provide the instructor with the 'Notice of Approved Accommodations' from OSD before accommodations will be provided. Arrangements for academic accommodations can only be made after the instructor receives the 'Notice of Approved Accommodations' from the student.

Students with approved accommodations are encouraged to submit the 'Notice of Approved Accommodations' to the instructor at the beginning of the semester because a reasonable amount of time may be needed to prepare and arrange for the accommodations.

Additional information about the Office for Students with Disabilities is available at http://www.austincc.edu/support/osd/.

Safety Statement
Austin Community College is committed to providing a safe and healthy environment for study and work. You are expected to learn and comply with ACC environmental, health and safety procedures and agree to follow ACC safety policies. Additional information on these can be found at http://www.austincc.edu/ehs. Because some health and safety circumstances are beyond our control, we ask that you become familiar with the Emergency Procedures poster and Campus Safety Plan map in each classroom. Additional information about emergency procedures and how to sign up for ACC Emergency Alerts to be notified in the event of a serious emergency can be found at http://www.austincc.edu/emergency/.

You are expected to conduct yourself professionally with respect and courtesy to all. Anyone who thoughtlessly or intentionally jeopardizes the health or safety of another individual will be immediately dismissed from the day's activity, may be withdrawn from the class, and/or barred from attending future activities.

Freedom of Expression
Each student is strongly encouraged to participate in class. In any classroom situation that includes discussion and critical thinking, there are bound to be many differing viewpoints. These differences enhance the learning experience and create an

atmosphere where students and instructors alike will be encouraged to think and learn. On sensitive and volatile topics, students may sometimes disagree not only with each other but also with the instructor. It is expected that faculty and students will respect the views of others when expressed in classroom discussions.

All discussion or conversation in the classroom should be appropriate and respectful of others.

Students and Instructional Services
ACC strives to provide exemplary support to its students and offers a broad variety of opportunities and services. Information on these services and support systems is available at: http://www.austincc.edu/s4/
Links to many student services and other information can be found at:
http://www.austincc.edu/current/
For help setting up your ACCeID, ACC Gmail, or ACC Blackboard, contact ACC Helpdesk at helpdesk.austincc.edu or 223-HELP.

Ownership of Student Work
The Architectural & Engineering Computer Aided Design (A&E CAD) Department reserves the right to retain any and all student work (including but not limited to: original work, scans, photographs, and copies of student work) completed as A&E CAD course work for the purposes of documentation, accreditation, evidence of student performance, university transfer, marketing or any other purpose supporting the mission of the Department and Austin Community College.

Concealed Handgun Policy

The Austin Community College District concealed handgun policy ensures compliance with Section 411.2031 of the Texas Government Code (also known as the Campus Carry Law), while maintaining ACC's commitment to provide a safe environment for its students, faculty, staff, and visitors.

Beginning August 1, 2017, individuals who are licensed to carry (LTC) may do so on campus premises except in locations and at activities prohibited by state or federal law, or the college's concealed handgun policy.

It is the responsibility of license holders to conceal their handguns at all times. Persons who see a handgun on campus are asked to contact the ACC Police Department by dialing 222 from a campus phone or 512-223-7999.