CS 2204 DIGITAL LOGIC & STATE MACHINE DESIGN FALL 2019

SYLLABUS

1. Professor : Haldun Hadimioglu

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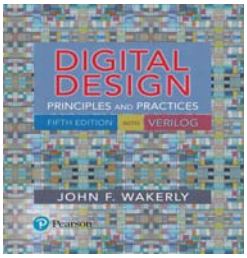
NYU Tandon School of Engineering, Computer Science and Engineering
Six MetroTech Center, Brooklyn, New York 11201

- Degrees : B.S. and M.S. in Electrical Engineering and Ph.D. degree in Computer Science
- Involved in the undergraduate Computer Engineering program administration
- Areas : Computer architecture, parallel (multi-core) processing, reconfigurable and nano systems

2. Prerequisite : CS1114 (C- required) or CS1133 (C- required).



3. Textbook :
The textbook : *Digital Design Principles and Practices*, John F. Wakerly, 5th edition, Pearson, 2018. ISBN : 13-9780134460093

- Author's web site : **http://www.wakerly.org.DDPP** has additional material.

4. What is asked from college graduates :

- **Good technical and non-technical skills** + **competency** + **grit** !
- **Adaptable**, **flexible** and **team player** !
- **Problem solver** + **systems oriented** in a **global environment** !

You may have also heard the following :

- You are **creative** and have **learning** as your target ! You **know how to learn fast !**
- **Good solid technical knowledge** + **learning fast** + **interpersonal skills**
- You have **analytical** and **synthesis** skills
- You have team work skills : **Interacting** with people to solve problems !
- You have good **documentation skills** !
- You are a **critical thinker** ! You **discover** and **explore** ! You are **lifelong learner** !

5. How to be successful in your college years and after graduation :

- Knowledge is **infinite** and it consists of pieces of information that are **dependent** on each other in infinite ways.
- Learning is **not** instant ! Learning is **not** easy ! It requires **physical changes** in the brain ≡ **Plasticity** ! That is, neurons in your brain are **rewired** as you learn. Rewiring the brain is **not** easy. It requires **constant** effort
- Applying/using what is leaned is **not** instant ! One needs time to apply/use the knowledge acquired, meaning additional rewiring in the brain is needed.

Otherwise, students try to recover by themselves. They just take exams. Professors cannot help them since these students are not around. It gets worse for students as the semester progresses and so no one can do anything ≡ It becomes **a vicious cycle**

- **Those students who need help are not around to get help !**

6. Why Digital Logic : Digital Logic is about d**igital hardware** which is used by all digital devices !

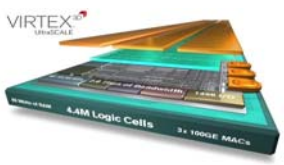
- Students who know hardware are good at **software** ≡ (**Operating Systems** + **Applications**).

7. Course Objectives : *What will you learn ?* Number systems, combinational circuits, sequential circuits, programmable components and digital systems.

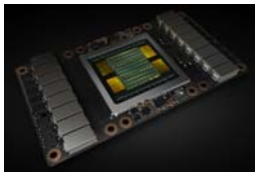
8. Course Outcomes : *What will you be able to do once the course is completed ?* Perform arithmetic in different number systems, design and analyze combinational circuits with or without programmable components, design and analyze sequential circuits, including digital systems and use current digital design techniques and tools to develop digital systems.

9. Course topics : CS2204 is about **digital circuits** (logic circuits) that make up digital hardware.

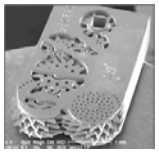
- It emphasizes **designing chips** that contain **digital systems,** by using the **finite state machine** approach (microprocesors, GPUs, custom chips, memory chips, etc.) ! **!**









10. The course format :

The course targets items listed in (4) and categorizes them as: *Intellectual*, *technical* and *non-technical*:

1) The *intellectual* goals are that students **learn how to learn fast** and are **critical thinkers**. This is necessary during one's lifetime ≡ The more you learn, the better for you !

2) *Technical* goals are for a successful career : Acquiring skills to be **systems oriented** and a **problem solver** as well as acquiring the necessary course content which is *digital logic* :

➔ **Main technical topic :** *Theory, design* and *analysis* of **digital circuits**. Digital circuits are building blocks of **digital systems** such as microprocessors and computers. Digital system fundamentals are covered in the context of finite state machine design and the term project.

3) The *non-technical* goals include acquiring and improving skills needed for **interacting with** and **managing people** in a global environment. They are needed in the technical world which is **team-based** and is **global**.

11. The course structure :

A **Computer Science and Engineering** (**CSE**) Department course

Lecture Section : **16364**

- **RH 215**, Tuesday and Thursday, 9:00 -10:50
- There is lecture capturing (**BriteClass**) in our classroom accessable via the NYU Classes Course Web Site

Lab Sections : **RH 227**

- ➔ **A** (**16539**, Friday 2:30 - 5:20)
- ➔ **B** (**16540**, Tuesday 2:30 - 5:20)
- ➔ **C** (**16597**, Friday 11:30 - 2:20)

12. Course web page : NYU Classes : Course handout and lab files are at the course web site

13. Exams : To test students for their technical knowledge and documentation
There will be **two** 110-minute midterm exams and a 2-hour final exam on class and lab topics.

- **Showing work** (showing intermediate steps) is required to get full credits on a question. That is, both the final answer and the steps to get it, the approach, are important.
  - ➔ These steps are given in class. Therefore, students are expected to solve exam questions as such.
  - ➔ Showing the approach also helps students acquire and improve their documentation skills, critical for the technical world.
    - ⇨ In order to facilitate this, the exams are **open book** exams : Students can use their own material, i.e. their books, notebooks, homework, handouts and lab material during the exams. Note that once the exam starts there is no sharing.
    - ⇨ Students must prepare for the exams as if they are **closed** book exams !
- In addition, remembering the following is needed during the exams :
  - ➔ No multiple answers to a question,
  - ➔ Precise answers to questions, no answers like "the rest is similar,"
  - ➔ Answering the question asked,
  - ➔ Use the exam booklet space well: For example, start a new question on a new page.

Overall, students are expected to show their technical knowledge and documentation

14. CS2204 Lab : The labs are directed by the professor. There are course assistants (we will call them TAs as we are more familiar with the acronym) to supervise students in the lab. Students learn practical aspects of digital logic and apply them by working on a project in the lab. The project is about developing **chips**, emulated on a **reconfigurable chip :**

- The lab reinforces and complements what students learn in the classroom. Also, the lab emulates the engineering design environment where engineers team up to design digital circuits piece by piece under the guidance of a project manager and senior engineers.
- The lab introduces current digital design tools and techniques, such as CAD tools to design hardware, **reconfigurable chips** (field programmable gate array, **FPGA**, chips), top-down, team-based, core-based design.
  - ➔ The CAD tool is the *Xilinx Vivado 2018.3* CAD tool and the FPAG board is the *Digilent NEXYS-4 DDR FPGA board with an Artix-7 FPGA chip*. Students install a smaller version of the Vivado **WebPACK 2018.3**, on their laptops to work on the termproject.
- The project is distributed to three phases, each making use of previous phases. **3**-/**4**-student teams are formed by the *third* week of the semester. Team members work on project phases and do the homework assignments together until the end of the semester.
- The lab affects the term grade. All three project phases are collected and graded if submitted on time. Students are expected to show they are good teammates. Attendance is recorded in every lab session. **Not** attending labs will lower the lab grade. **Not** attending lectures and labs may result in being separated from the team. How to determine the lab grade will be given in the second week.
- The lab is **227RH** which is a **CSE** lab. Each section has two hours and 50 minutes a week in the lab. Lab sessions start with a presentation by the professor or a TA. Then, students work on the current phase under the supervision of TAs. Students need to attend their lab section to work with their teammates. Also, the lab is available to students with a TA present (open lab hours).

15. Homework :
There will be six homework assignments. **An assignment submitted late will not be accepted**. The homework is submitted by **teams**.

➔ *Students who do homework are faster at sol*ving problems. Showing work (intermediate steps) is

required to get full/partial credits on a question. howing work helps students improve their documentation. The homework will be graded by the TAs. Although, the homework will **not** affect the term grade, it can help raise grades as explained below.

- Homework assignments have relevant questions and answers to help learn chapters and solve homework problems. Students need to study them **before** they solve homework problems, not before exams.

16. Term Grade : The numerical term grade calculation is as follows:

10% Labs **20%** Exam I **25%** Exam II **45%** Final Exam

- To earn 10% for the Labs, students must work well together (attendance, concentration and cooperation) and do the term project and homework well. Its calculation will be shown in the lab in the second week.
- The homework does not affect the term grade directly but it is taken into account when a student's term grade is near a grade "border." Also, taken into account are attendance and lab performance. If they are good, the grade is raised. Finally, the professor may change the term grade computation. Thus, students are strongly suggested that they fulfill the requirements of the course, i.e. lectures, labs and homework assignments.

17. Material Coverage :
All chapters of the textbook are covered, some partially and some completely. Students are given additional material in class. The **tentative** schedule is as follows :

Days	Subject	Textbook Chapter(s)
Sep 3	Introduction. Course overview	1
Sep 3, 5, 10 12, 17	Number systems and binary arithmetic. Coding, error detection and correction	1, 2, 5 and 8
Sep 19, 24, 26, Oct 1, 3, 8	Overview of digital hardware. Gates. Small combinational circuit analysis and design.	1, 3, 4, 5, 6, 7, 8 and 14
Oct 17	EXAM I : It is **tentative**. It can be earlier or later	HW : 1, 2
Oct 10, 22, 24, 29, 31, Nov 5	Synchronous sequential circuit fundamentals. Analysis and design small sequential circuits ; Popular large sequential circuits. Large sequential circuit design by using popular large sequential circuits.	1, 5, 9, 10, 11, 12, 13
Nov 14	EXAM II : Cumulative : It is **tentative**. It can be earlier or later	HW : 1 - 4
Nov 5, 7, 12	Digital systems : Introduction to state machine design, Datapath and Control Unit design.	1, 5, 9, 10, 11, 12, 13
Nov 19, 21, 26, Dec 3	Popular large combinational circuits. Large combinational circuit design by using popular large combinational circuits.	1, 3, 4, 5, 6, 7, 8 and 14
Dec 5, 10	Programmable logic : Semiconductor memory chips, ROMs and RAMs. Combinational programmable logic : MUXes, Decoders	1, 5, 6 and 15
Dec 12	Future projections. Questions and answers	All chapters
TBA	Final exam : Cumulative. **All the above chapters**	HW : 1 - 6

18. Office Hours :

The professor has an **open-door** policy that if he is not busy, students can ask questions in his office. If the door is closed, he might be teaching or at a meeting. If a student wants to see the professor at a certain time, he/she makes an appointment with the professor.

- Students are requested that they see the professor to ask questions. Broadcast messages will be sent to the class to make announcements. Please note that grades are not given out to students via email or telephone. Students need to see the professor to learn their grades.
- There are TAs to help students. TA assignments and their contact information will be given at the course web site and in class later in the semester.

19. References :

Students are suggested that they study **recent** digital logic books since the field advances rapidly. The books below are recommended with respect to their relevance to the course and the textbook :

a) *Fundamentals of Logic Design*, C. H. Roth, Jr. and L. L. Kinney, 7th edition, Cengage Learning, 2014. ISBN : 978-1-133-62847-7.
b) Fundamentals of Digital Logic with VHDL Design, S. Brown and Z. Vranesic, 3rd edition, McGraw-Hill, 2014. ISBN : 978-00-733-80544.
c) *Digital Design*, M. Moris Mano and Michael D. Ciletto, 5th edition, Prentice-Hall, 2013.
d) *Digital Design : A Systems Approach*, William J. Dally and R. Curtis Harting, Cambridge University Press, 2012.

A book describing how and why technical work in computer design and development is a small part of a larger picture that also includes emotions, ambitions and conflicting goals of many people involved : *Dealers of Lightning : Xerox Parc and the dawn of the Computer Age*, Michael A. Hiltzik, Harper Business, 1999.

Students are also suggested that they read the following book that describes learning by mistakes : *Little Bets: How Breakthrough Ideas Emerge From Small Discoveries*, Peter Sims, Simon and Schuster, 2011.

20. ABET Core 1-7 Competencies :

1) Students identify, formulate, and solve complex engineering problems by applying principles of engineering science, and mathematics.

2) Students 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.

21. Reminders about the course:

Students need to read and remember web pages whose links are also provided at the course web site :

1) **NYU Code of Conduct web page :** http://engineering.nyu.edu/files/SACCofC2-2-16.pdf, including *academic misconduct*, which is a part of the Student Code of Conduct document.

2) **NYU-SOE Life web page with links to Student Affairs, Public Safety, Students Resources and other :** http://engineering.nyu.edu/life.

In addition, students need to keep the following in mind :

a) Keeping contact with the professor and discussing personal matters in professor's office help you considerably

b) A successful course experience : To enjoy the course as much as possible and be ready for the follow up courses, students need to be committed to the course

- **Attending classes** and **labs** and **doing the work** are needed.

c) Students must realize that every action they take has consequences. Making assumptions and decisions on the course (the exams, lectures, labs, the homework and attendance) without asking the professor often lead to problems for students.

d) A reason for a low grade is **missing classes** and **labs**. Even if one gets the notes, it does **not** help. This is because :

- The notes taken from the board may not be correct.
- Someone taking the notes may not write down all the verbal comments and suggestions made by the professor.
- Attending classes and labs forms better memory because of visual (seeing the writing on the board), audio (listening to the professor) and tactile (writing down the notes) inputs.
- During lectures and labs, the professor refers to earlier lectures and labs (past topics, comments, suggestions, etc.) which refreshes students' memory and further reinforces their knowledge.

Overall, students learn and remember more. Finally, since their memory is fresh, students save time when they study for exams.

e) Missing an exam is **not** a minor case. A careful assessment is made to excuse a student or to grant an incomplete to a student. The professor makes the decision. The decision is made also based on the information by the student's academic department and the Student Affairs Office.

- One of the requirements to excuse a student is that at the time the student is not able to take the exam, he/she **be in good standing in class**, i.e. has good attendance, a good homework performance, a good lab performance and a good exam performance : The professor wants to see that the student has been committed to the course and learning the material has been his/her main objective.
- A student who is excused from a midterm exam is **not** given a make-up exam. The weight of the midterm exam is distributed to the other exams at the discretion of the professor. The make-up exam for the final exam will be harder than the one given to the whole class.

f) If a student experiences problems, including health/personal problems, he/she immediately contact **Deanna Rayment** who is the Coordinator of Student Advocacy, Compliance and Student Affairs. Her contact information is :

- **deanna.rayment@nyu.edu**
- **(646) 997-3046**
- **LC 240C**

g) For a course, the semester is over when the final exam is over. Students are **not** given extra work, a project, a make-up exam or any other kind of special treatment to raise their grade during or after the semester.

h) Some students do not know/follow NYU-SOE and CS2204 rules and regulations nor seek advice from Tandon staff. Students are strongly suggested that **they speak with the professor**, the TAs, the major advisor, the personnel of the Student Affairs Office, and the Counseling Center for a better experience.

22. Moses Center Statement of Disability :

If you are a student with a disability who is requesting accommodations, please contact New York University's Moses Center for Students with Disabilities (CSD) at ((212) 998-4980 or mosescsd@nyu.edu. You must be registered with CSD to receive accommodations. Information about the Moses Center can be found at www.nyu.edu/csd. The Moses Center is located at 726 Broadway on the 3rd floor in Manhattan ((212) 998- 4980). ***Please do this at the start of the semester.***