The mission of Concord University is to provide quality, liberal arts based education, to foster scholarly and creative activities and to serve the regional community (http://www.concord.edu/academics/).

CS 271 – Computer Organization and Hardware

20155, Section 01

Semester Taught: Spring 2019	**Professor:** Lonnie Bowe
	(Mr. Bowe or Professor)
Credit Hours: 3	**Office Location:** Science 100E
Prerequisites: CS 202	**Office Hours:** MWF 7:30 am – 8 am, MWF 3pm-4pm
Course Time: TR 9:30 am – 10:45 am	TR 1:30pm – 2:00pm
Building and Room Number: Science 103	Other Times by Appointment
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	College/Department Website: http://math.concord.edu

Course Description/Rationale: Fundamentals of computer hardware. How computer hardware works from the bottom up, starting at the circuit level and ending at the operating system level. Topics include: Boolean Logic and Circuits, Boolean Arithmetic, Assembly Language, CPU Architecture, Memory Organization, Assembler Implementation, Syntax Analysis and Code Generation.

Course Management System: https://moodle.concord.edu

Hardware/Software Needed: https://www.concord.edu/technology/node/23

Text requirements: The Elements of Computing Systems
            by Noam Nisan and Shimon Schocken
            ISBN 978-0262640688

            Learning Computer Architecture with Raspberry Pi
                by Upton, et al
                ISBN 978-1119183938

Concord University Educational Goal(s):

Skills: (1) Effective inter-communication skills and literacy adapted as needed for the demands of various kinds of discourse.
(2) An ability to employ appropriate observational, logical, analytical, computational, creative, and critical thinking skills within and across academic disciplines; and to apply these skills in problem-solving.

National Standards: CS 271 comprises most of the topics recommended by the ACM in its 2013 Curriculum Guidelines for Undergraduate Degree Programs in Computer Science (See page 62: "Architecture and Organization" and page 186: "Systems Fundamentals"). The ACM report can be found here: http://www.acm.org/education/curricula-recommendations

Specific Learning Outcomes:

1. Describe the progression of computer technology components from vacuum tubes to VLSI, from mainframe computer architectures to the organization of warehouse-scale computers.

2. Comprehend the trend of modern computer architectures towards multi-core and that parallelism is inherent in all hardware systems.

3. Explain the implications of the "power wall" in terms of further processor performance improvements and the drive towards harnessing parallelism.

4. Articulate that there are many equivalent representations of computer functionality, including logical expressions and gates, and be able to use mathematical expressions to describe the functions of simple combinational and sequential circuits.

5. Design the basic building blocks of a computer: arithmetic-logic unit (gate-level), registers (gate-level), central processing unit (register transfer-level), memory (register transfer-level).

6. Use CAD tools for capture, synthesis, and simulation to evaluate simple building blocks (eg, arithmetic-logic unit, registers, movement between registers) of a simple computer design.

7. Evaluate the functional and timing diagram behavior of a simple processor implemented at the logic circuit level.

8. Explain why everything is data, including instructions, in computers.

9. Explain the reasons for using alternative formats to represent numerical data.

10. Describe how negative integers are stored in sign-magnitude and twos-complement representations.

11. Explain how fixed-length number representations affect accuracy and precision.

12. Describe the internal representation of non-numeric data, such as characters, strings, records, and arrays.

13. Convert numerical data from one format to another.

14. Write simple programs at the assembly/machine level for string processing and manipulation.

15. Explain the organization of the classical von Neumann machine and its major functional units.

16. Summarize how instructions are represented at both the machine level and in the context of a symbolic assembler.

17. Demonstrate how to map between high-level language patterns into assembly/machine language notations.

18. Explain different instruction formats, such as addresses per instruction and variable length vs fixed length formats.

19. Explain how subroutine calls are handled at the assembly level.

20. Write simple assembly language program segments.

21. Show how fundamental high-level programming constructs are implemented at the machine-language level.

22. Identify the main types of memory technology (eg, SRAM, DRAM, Flash, magnetic disk) and their relative cost and performance.

23. Explain the effect of memory latency on running time.

24. Describe how the use of memory hierarchy (cache, virtual memory) is used to reduce the effective memory latency.

25. Identify various types of buses in a computer system.

26. Explain the differences between shared and distributed memory.

27. Describe the SMP architecture and note its key features.

28. Characterize the kinds of tasks that are a natural match for SIMD machines.

29. Explain how programs that process other programs treat the other programs as their input data.

30. Describe an abstract syntax tree for a small language.

31. Describe the benefits of having program representations other than strings of source code.

32. Write a program to process some representation of code for some purpose, such as an interpreter, an expression optimizer, or a documentation generator.

33. Distinguish a language definition (what constructs mean) from a particular language implementation (compiler vs interpreter, run-time representation of data objects, etc).

34. Distinguish syntax and parsing from semantics and evaluation.

35. Sketch a low-level run-time representation of core language constructs, such as objects or closures.

36. Identify and fix memory leaks and dangling-pointer dereferences.

37. Describe the basic building blocks of computers and their role in the historical development of computer architecture.

38. Design a simple logic circuit using the fundamental building blocks of logic design.

39. Use tools for capture, synthesis, and simulation to evaluate a logic design.

40. Describe how computing systems are constructed of layers upon layers, based on separation of concerns, with well-defined interfaces, hiding details of low layers from the higher layers.

41. Describe that hardware, VM, OS, application are additional layers of interpretation/processing.

42. Explain the distinction between program errors, system errors, and hardware faults (eg, bad memory) and exceptions (eg, attempt to divide by zero).

43. Articulate the distinction between detecting, handling, and recovering from faults, and the methods for their implementation.

44. Describe the role of error correcting codes in providing error checking and correction techniques in memories, storage, and networks.

45. Apply simple algorithms for exploiting redundant information for the purposes of data correction.

46. Compare different error detection and correction methods for their data overhead, implementation complexity, and relative execution time for encoding, detecting, and correcting errors.

Course Requirements:

9 Projects: NAND2Tetris Projects from the Elements of Computing Systems textbook.
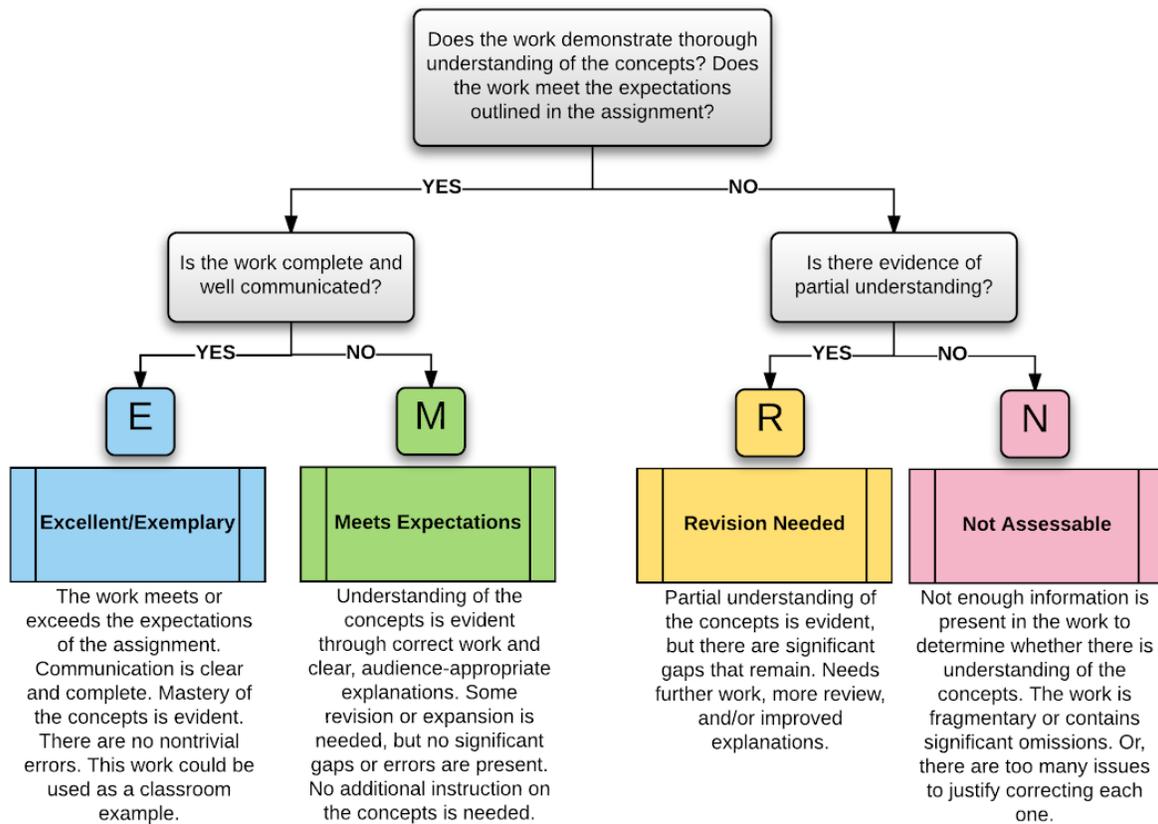
4 C Exercises: Exercises intended to teach you the C programming language.

12 Reading Responses: Communication is an important but neglected skill for students. You will regularly receive assignments where you must read, explain or present new information.

10 Quizzes: There will be short quizzes based on the project and lecture materials.

Grading Policy

All coursework, other than the Final Exam, will be graded on the EMRN system (http://rtalbert.org/specs-grading-iteration-winner/).

Does the work demonstrate thorough understanding of the concepts? Does the work meet the expectations outlined in the assignment?

YES — Is the work complete and well communicated?

NO — Is there evidence of partial understanding?

YES → **E**
NO → **M**
YES → **R**
NO → **N**

E — Excellent/Exemplary
The work meets or exceeds the expectations of the assignment. Communication is clear and complete. Mastery of the concepts is evident. There are no nontrivial errors. This work could be used as a classroom example.

M — Meets Expectations
Understanding of the concepts is evident through correct work and clear, audience-appropriate explanations. Some revision or expansion is needed, but no significant gaps or errors are present. No additional instruction on the concepts is needed.

R — Revision Needed
Partial understanding of the concepts is evident, but there are significant gaps that remain. Needs further work, more review, and/or improved explanations.

N — Not Assessable
Not enough information is present in the work to determine whether there is understanding of the concepts. The work is fragmentary or contains significant omissions. Or, there are too many issues to justify correcting each one.

EMRN rubric based on the EMRF rubric, due to Rodney Stutzman and Kimberly Race: http://eric.ed.gov/?id=EJ717675

Each assignment will come with a revision policy and timeline.

Grading Scale

To Earn a D: You must earn a grade of M or better on 8 Readings, 6 Quizzes, 2 C Exercises, and 6 Projects.

To Earn a C: You must earn a grade of M or better on 9 Readings, 7 Quizzes, 3 C Exercises, and 7 Projects.

To Earn a B: You must earn a grade of M or better on 10 Readings, 8 Quizzes, 3 C Exercises, and 8 Projects.

To Earn an A: You must earn a grade of M or better on 11 Readings, 9 Quizzes, 4 C Exercises, and 9 Projects.

Late Assignments: Late assignment policies vary with the type of assignment. Each assignment will detail the late policy.

Missed Quizzes: You have 36 hours from the start time of the quiz to contact the instructor about a makeup quiz. You must have a valid reason for missing the quiz. Makeup quizzes may have different questions covering the same content as the regular quiz. Makeup quizzes must be taken within four week days of the original quiz.

Grade Disputes:	If you disagree with a grade or believe it is inaccurate, you may contest your grade within 7 calendar days from when the grade was released. After the 7 day **period, the grade becomes final.**
Course Timeline:	Students should expect at least one reading assignment per week, with frequent programming assignments. A full, tentative schedule will be posted to Moodle.
Attendance:	You need to come to class. Attendance is encouraged. Participation exercises will be given regularly and are worth a portion of your final grade. Attendance and participation are important factors in all classes. This class, in particular, moves at a good pace and it is better for you to be there, even if you are half asleep. If you are sick, it is recommended that you stay home rather than infect the entire class.

Participation exercises will often involve working in small groups and therefore cannot be completed at a later date. Note that this policy does not distinguish "excused" from "unexcused" absences – such a distinction puts me in a role I don't want to play. University approved activities are exempt from this distinction. As always, exceptions will be made for extraordinary circumstances.

Attendance policy influenced by Brian Croxall, Emory Unitversity

The instructor follows the official University policy on student safety. Inclement weather conditions will be taken into consideration in regard to the attendance policy. http://www.concord.edu/emergency-alerts

Contact Policy:	The instructor uses e-mail for class announcements. Please check your Concord e-mail at least once a day. You are responsible for the content of the e-mails.

The instructor is here to assist you. Remember that you can stop by during office hours, make an appointment, post on the course forum or send an e-mail! Please email from you MyCU email address.

When e-mailing the instructor, please allow for plenty of time to get a response as the instructor isn't always online.

Feedback Policy:	It is my goal to give you timely, constructive feedback on your performance in this class. However, I cannot know how I am performing without feedback from you. I encourage you to let me know how I am doing, what you like and dislike about the course.

This feedback will in no way impact your grade. Do not suffer in silence. If speaking to me in person makes you uncomfortable, I will also periodically provided anonymous surveys on Moodle for you to express your opinions.

Cell Phone, Tablet, Laptop, work from other classes, etc. Policy:	It is best if you are engaged in the class, if I feel that you are not, then I reserve the right to remove you from the classroom.

Other policies may be distributed in class or on Moodle. Students will be held responsible for these policies.

Mandatory Syllabus Statements that apply to all CU courses:

Accessibility/Accommodations:

Concord University is committed to responding to the needs of students with disabilities as defined by the Americans with Disabilities Act. Please inform your instructor at the beginning of the class semester if you have a disability and are requesting accommodations. It is your responsibility to self-disclose that you are requesting accommodations. The University and instructor will provide you with a reasonable accommodation. You should register with CU's Disability Services Office, located in the Athens campus Jerry and Jean Beasley Student Center, Bottom Floor, across from the Campus Post Office. The Disability Services Office phone is 304-384-6086 or you can email the Director, Nancy Ellison, at nellison@concord.edu for assistance.

Academic Dishonesty

Academic dishonesty is morally unacceptable as well as destructive to the learning and teaching atmosphere. Academic dishonesty includes the giving or receiving of improper help on examinations or assignments, falsifying documents, and plagiarism (the act of stealing and using, as one's own, the ideas or the expression of the ideas of another). Such dishonesty can lead to a variety of penalties — including but not limited to failure of assignment, failure of course, loss of institutional privileges, or dismissal from the University. (See University Catalog Academic Policies and Procedures.)

Concord University Honor Code

A Concord University Honor Code was approved by students, staff, faculty, administration, and the CU Board of Governors. The Code states:

"As a member of the Concord University Community I will act with honesty and integrity in accordance with our fundamental principles and I will respect myself and others while challenging them to do the same."

The Honor Code is intended to unite the Concord community behind a culture of honesty, integrity, and civility.

Class/Online Attendance Policy

Regular class attendance is part of a student's academic obligation at Concord. Irregular attendance may affect academic performance adversely and is detrimental to the atmosphere of a class. (See University Catalog Academic Policies and Procedures.)

Emergency Alert System

In an effort to increase safety and security on our campus, Concord University encourages everyone to register for instant text message alerts. Alerts will only be used for security and safety notices. All students, faculty, and staff are eligible to receive text message alerts on their cell phones or email alerts. Please contact the IT Help Desk for further assistance (304-384-5291).

Emergency Information

Emergency/courtesy telephones are located at the main entrance of each residence hall and at various other locations on campus. Emergency telephones can be identified by the flashing blue light and will provide the user with a direct link to Public Safety at the press of a button. To report an on-campus emergency, call 304-384-5357 or 911. The Office of Public Safety is located on the bottom floor of the Rahall Technology Center. For further emergency information go to: http://www.concord.edu/administration/office-public-safety.

Inclement Weather Policy

As a general policy, the University will remain in normal operations during adverse weather conditions. In the event of severe weather conditions, the following may occur:

No students or employees are to report.

Classes Cancelled
Students do NOT report BUT employees are expected to report to work at their normal time.

Operating on an Inclement Weather Delay
Under this schedule, all 8 a.m. classes will start at 10 a.m. Students and faculty will follow the Inclement Weather Schedule. (See http://www.concord.edu/emergency-alerts for Athens/Beckley Inclement Weather Schedules.)

Announcements invoking the late schedule or other options referenced above are aired on area radio and television stations and are sent as text and email messages to those enrolled for this service.

Student Conduct

In classrooms, online, laboratories, and during any activities that are part of course requirements, students are expected to observe reasonable rules of conduct.

Sexual Harassment & Assault

 Federal law, Title IX, and Concord University policy prohibits discrimination, harassment, and violence based on sex and gender (Including sexual harassment, sexual assault, domestic/dating violence, stalking, sexual exploitation, and retaliation). If you or someone you know has been harassed or assaulted, you can receive confidential counseling support through the Concord University Counseling Center (304-384-5290). Alleged Violations can be reported non-confidentially to the Concord University Title IX Coordinator at 304-384-6327 or titleix@concord.edu. Reports to Campus Security can be made at (304-384-5357). As an employee at Concord University, I am a mandatory reporter which means I must report any sexual misconduct I am made aware of. This includes verbal or written (such as in an assignment) disclosures of sexual harassment or sexual assault.

Technology Services

Contact the CU Help Desk at extension 5291 from campus or 304-384-5291 off campus. You may also e-mail cuhelpdesk@concord.edu.

Syllabus Disclaimer

"This syllabus is subject to change based on the needs of the class. Please check it regularly."