CMP230 **Introduction to Computer Architecture and Assembly Language**

Credits: 3 (Lab required) Pre-requisites: CMP128

Time/Location: Thu 2:15pm – 5:45pm Section 80234

Instructor: Geoffrey J. Cullen
email: gcullen@ccm.edu (only acceptable email contact)
website: http://cullenprogramming.dyndns.org/profnotes.html
Google: CullenProgramming

Suggested Text: "Computer Organization and Design", Patterson and Hennessy,
(not required) publisher: Morgan Kaufmann

Other Sources: NetWide Assembly Language
http://www.nasm.us/doc/nasmdoc1.html
IBM z/Architecture Principles of Operation (available on web)
publisher: IBM Corporation

Required Reading
by midterm: "ENIAC: The Triumphs and Tragedies of the World's First Computer",
Scott McCartney, 2012, Blackstone Publishing
"Computational Thinking", Peter Denning and Matti Tedre, 2019, MIT Press,
Chapter 1, What is Computational Thinking
Chapter 2, Computational Methods
Chapter 3, Computing Machines
by final exam: "The Pleasure of Finding Things Out: The best short works of Richard P. Feynman",
Carl Feynman, Michelle Feynman, 1999,
Chapter 2, "Computing machines in the future"
Chapter 7, "Minority report on the Space Shuttle Challenger inquiry"
"In Our Own Image", George Zarkadakis, 2015,
Chapt 13, "The Program""
Chapt 14, "From Bletchley Park to the Google Campus"

Required Viewing: "Silicon Valley -- Where the Future was Born", American Experience,
PBS, 2013, 90 minutes.
"Computer Pioneers": Pioneer Computers Part 1 - YouTube, 55 mins
"Computer Pioneers": Pioneer Computers Part 2 - YouTube, 55 mins

Required Equipment: Backup media to save programming assignments, exercises, scripts, configurations, etc. Ability to connect with the CCM lab system via SSH.

Requisite Familiarity: Basic UNIX commands, (See HOW TO page on my website)
Basic VI Text Editor commands

The school provides the necessary Unix laboratory facilities, but if student chooses to also install a lab environment on their own computer then the following are the recommended software components:

Recommended utilities, only if you wish to build your own development platform outside of class.

Assemblers:	NetWide Assembler (NASM)
and utilities:	GCC compiler and Linker, ELF64 Utilities
	VI Text Editor

Description: This course is an introduction to computer architecture and organization. Topics covered range from an overview of the early Von Neumann model through modern architectural models. Other topics presented include data representation, digital logic and theory, exposure to assembly language and its relation to the architecture, interruption processing and the operating system interface, memory addressing and storage, conditional branching, fundamental machine logic gates, Input/Output processing. Basic principles of assembly language programming for both IBM and Intel architectures are explored. Problems and exercises implementing the above topics are assigned.

Topics Include:
- Architectural History
- Machine Language
- Computer Organization
- Assemblers, Compilers, Linkers and Loaders
- Addressing and Addressability
- Computation and Arithmetic fundamentals
- CPU Pipeline Processing
- Interrupt and Exception Handling
- Real and Virtual Memory
- Information Caching
- Multiprocessing and Multitasking
- Dynamic Address Translation
- Virtual Machines and Hypervisors
- The Input-Output Interface

Course Objectives: To provide an understanding of the designed behavior of the computer under fundamental programming conditions. The relationship and interaction between hardware and software. Be familiar with virtual storage and memory addressing. Understand how a computer system works and why it performs as it does. Be introduced to Assembly Language programming.

Learning Outcomes:
Describe the historical progression of computer development and the significance of the Von Neumann model.
Demonstrate how data can be represented in digital form and its limitations.
Perform logical and arithmetic data operations.
Explain how Boolean operations are manifested in digital components.
Discuss the basic organization of a modern computer and its subsystems.

Describe how these subsystems work together to execute programs.
Describe machine-level instructions, its purpose, format and memory addressing.
Implement assembly language programs which incorporate the various classes of instruction; data movement, arithmetic, logical and conditional flow control.
Explain what system software is and the purpose and functionality of assemblers, compilers, linkers and loaders.
Identify the memory and storage technologies found in a computer and specify the cost-performance trade offs. Understand simple paging and segmentation strategies.
Explain the mechanisms that are used to control and communicate with I/O and storage devices.
Describe the concept of parallel processing and the relationship between parallelism and performance.

Knowledge and Competencies: Become familiar with computer machine language requirements and the different levels of computer organization, and the reasoning behind current hardware architecture. Acquire an understanding of the designed behavior of the computer. Be able to intelligently discuss and master the subject matter presented in this course. Develop an appreciation for the complex and detailed nature of computer architecture.

Performance: Be able to discuss hardware and software logic techniques.
Show proficiency in describing machine and human computer languages.
Demonstrate proficiency in understanding fundamentals of computer architecture.

Attendance Policy: Students are expected to attend all class sessions and are responsible for all material presented in class, all homework, labs and reading assignments. If a student has more than **2** unexcused absences, his/her final grade will be lowered by 10 points, then an additional 10 points for each additional occurrence. Excessive absence may be considered sufficient cause for dismissal from class. It is the responsibility of the student to obtain information regarding missed work and lectures from sources other than the instructor. I do not review students' missed lectures. Contact me in advance when you know that you will be missing any class session to avoid an attendance penalty.

Lateness Policy: Students must inform the instructor in advance if they will be late. If the student is late 3 times in excess of 20 mins, the lateness will count as an absence and you will be penalized for 1 class participation unit. The same applies for leaving a class early. It is your responsibility to ensure that the instructor has recorded you as being present.

Class Participation: A significant portion of your grade is based upon class participation. (see below) When lesson material is presented during lecture, students are to participate in the learning process. Students are to be engaged as directed by the instructor. It is expected that you will participate enthusiastically and frequently at every class meeting in all course material discussions. Attendance is not sufficient for participation. Students are expected to stay for the full class length. When you have

questions regarding the subject matter you must ask them during the class period; not during breaks or after class. Electronically raise your hand to be recognized. You will be penalized class participation units for using any distractions during class. Each student may be called upon to discuss the current topic. You are evaluated by your effort and mastery of course knowledge. If you are wearing earbuds, hoodies over your head, or other such then you are clearly indicating that you are not interested in the lecture or discussion. I will note the incidence without any discussion with you, and deduct grade points as I determine appropriate.

Homework: Reading will be assigned as well as questions relating to the covered topic. The homework is intended to reinforce the material presented in class and to prepare the student for class discussions and examinations. The student is expected to be prepared to discuss all assignments in class. You are also expected to complete the labs and to review all lecture notes. If you are not prepared for a lecture it will be readily noticed.

Work Submission: All assignment materials and homework must be available on your school provided lab workspace. Work and source-code must be checked for accuracy, be well documented with comments, correctly named, neatly formatted, easily readable and meet stated functional specifications. Work is expected by the due dates. If you did not receive a response to your email you must assume that it did not reach me. Keep a copy of my reply. This is your proof that I acknowledged your email. If you are missing deadlines then it is not likely that you will be successful in this course. Lab assignments are due two weeks after the lab has been assigned. No work is accepted on the day of the final exam. Grades are based on the timeliness and the quality of work completed. **Lab work MUST be well tested.** Have your fellow students test your work for completeness and correctness.

Communications: All communication outside of class must be via the college email system. I will make every attempt to respond within 2 business days of the message receipt.

Other Student Expectations: Communicate often with the instructor about any concerns or problems.
By FERPA legislation, I can discuss student concerns only with the student.
Take notes on the ideas, facts and concepts presented. The student is expected to be familiar with text editing. Perform all reading assignments on time. Be prepared to discuss material in class. Put forth a maximum effort to learn and master the subject material with interest and persistence. Note that the class schedule is "tentative" and subject to change. It is your responsibility to be aware of changes made to the schedule. A student in this course is expected to spend at least two hours of study for every hour in the class, therefore I expect each student to spend 6 to 8 hours a week outside the classroom working on programs and studying related materials.
The instructor provides "website" notes to supplement lecture and reading materials. These notes are not to be considered a substitute for class attendance. I update these notes frequently during the semester. Information discussed in lectures may not be covered in the notes. Students are encouraged to interrupt lectures for topic related

questions. Signal electronically or Raise your hand to be recognized. Ask questions, take notes.

Assembly Language: The student is expected to research and study the x86 64-bit NASM Intel assembly language outside of classroom hours. Your CCM laboratory has been designed to be accessible from anywhere and available at anytime. You are encouraged and expected to explore, experiment, test and explain your use of the various assembly mnemonics and logic used in the labs.

Other Student Responsibilities: Each student is held responsible for the following:
Be aware of dates on the college calendar including the last date for withdrawal.
Understand all the information contained in this syllabus.
Use the college website for any information with regards to cancellations.
Check their assigned college email each and every day.
Be familiar with the full contents of the Student Handbook and all college policies.
Understanding the policy on "Academic Integrity".

Late Work Policy: All projects and assignments are to be submitted on the designated due date
Be aware that late work will affect your grade. Work submitted late will be marked off 10 percent for every class session the assignment is late. You will not be reminded to complete your work. It is your responsibility to get your assignments in on time regardless of computer problems or scheduling.

Missed Exam Policy: Exams missed due to an excused absence must be made up within reasonable time. Arrangements for make-up exams must be made between the instructor and the student prior to the scheduled exam. Exams missed due to an unexcused absence cannot be made up and will receive a **zero** grade. Should you need to miss an exam you must inform the instructor well in advance.

Data: It is the student's responsibility to ensure that his/her work is backed up and recoverable from reliable media. There will be no acceptable excuse for lost or inaccessible assignments. Your computer's integrity is your responsibility. Any problems with campus equipment, network, hardware or software must be directed to the IT Department and Solutions Center by the student.

Cheating: Cheating on examinations, through use of unauthorized aids or inappropriate resources is forbidden. In addition, plagiarism, or the unattributed use of another persons words, code, algorithms or ideas, through either direct appropriation or paraphrase, is a serious breach of academic standards. Collaboration unless so instructed by the instructor is cheating. If you are found to be cheating you will be given an "**F**" for the course.

Electronic Equipment: No phones are permitted to be audible during class. No phones are permitted on your person during exams. Computing equipment is permitted for classroom assignments. Text messaging, audio, social networking and non-course related Internet use is prohibited at all times.

Academic Conduct In order to maintain academic integrity, the college community will not tolerate any forms of academic dishonesty. Academic integrity is in effect at all times in this course. I expect that all papers, exams, quizzes, and laboratory assignments submitted by each student reflects his/her own work, and that he/she did not give or receive unauthorized aid in any of this work. Students may not collaborate in the preparation of assignments, papers, laboratory assignments, or examinations without the expressed permission of the instructor. Examples of unacceptable forms of dishonesty include cheating, copying, fabrication, plagiarism, unauthorized collaboration, submitting someone else work as one's own; dishonesty through the use of technology such as sharing disks, files, or programs; access to, modification of, or transfer of electronic data, system software or computing facilities.

Failure to abide by these expectations may result in the faculty member submitting a formal complaint of the incident to the Office of Student Development & Enrollment Management. The Vice President will refer the complaint to the Academic Integrity Review Board, which is composed of faculty, academic administrators, and the Vice President of Student Development & Enrollment Management. The Academic Integrity Review Board will review the circumstances surrounding the incident and make a recommendation of appropriate disciplinary action. Penalties imposed on the student who violates this policy may vary from failing the unit of work to expulsion from the college. Violations of this policy are recorded permanently on the student's transcript.

CCM Policy on Virtual Learning Classroom Protocols

The County College of Morris Student Code of Conduct applies to the virtual learning environment as well as the on-campus environment. Students must remember that you are in a teaching and learning environment and therefore should conduct yourself as you would in an on-campus classroom environment. Disruptive students may be muted and/or removed from a the remote class if necessary. Towards that end, students should abide by the following virtual learning classroom protocols for this class:

(1) Have your camera on when you arrive to the class and throughout the class meeting. If there is an extenuating reason for why you cannot turn on your camera, please contact your instructor in advance of the class meeting to discuss.
(2) Remember to look at the camera to make eye contact when speaking.

(3) Avoid outside distractions. In other words, there should not be other people or animals around you, or anything too distracting on the walls such as inappropriate posters, etc.
(4) Background noises, such as TV sound, radios, dog barking, etc., should be minimized as best as possible. Optimal learning will occur in a quiet environment.
(5) Mute your audio when you were not speaking.
(6) If the chat feature is allowed, remember to use only appropriate material and language relevant to the class in a chat.
(7) Dress in an appropriate manner fitting for a learning environment and as if you are in an on-campus classroom setting.
(8) Avoid side conversations.

STUDENTS SEEKING DISABILITY ACCOMMODATIONS:

In accordance with the policies underlying Section 504 of the Rehabilitation Act of 1973, the American with Disabilities Act (ADA) of 1990, the ADA Amended Acts (ADAA) of 2008 and County College of Morris policy, no qualified individual with a disability shall, solely on the basis of that disability, be excluded from participation to County College of Morris programs or activities. Students may seek reasonable accommodations for their documented disability by self-identifying and registering with the Office of Accessibility Services. Students who are approved through Accessibility Services for classroom accommodations are encouraged to meet with faculty members on an individual basis to discuss their specific needs. To register or learn about services, students may contact the Office of Accessibility Services at 973-328-5284 or disabilityservices@ccm.edu

CCM ACADEMIC POLICIES

CCM Academic Policies may be viewed on the college web site at:
http://www.ccm.edu/academics/policies.aspx
or in the CCM College Catalog. All students enrolled at the County College of Morris are required to read the CCM Policy Statements.

CCM POLICY GOVERNING ACCESS TO AND USE OF COPYRIGHTED WORKS

Today it is easier than ever to share written and recorded material with others. CCM makes extensive use of technology to enhance instruction and learning. It is very important to recognize that most works found on the internet (as well as in books and journals) are protected by copyright—so you should be careful to make use of them in manner that is proper for your education. Improper use or sharing of copyrighted work is a violation of the Student Code of Conduct and Copyright Law.

The full CCM policy is found at: http://www.ccm.edu/Media/Website%20Resources/pdf/aboutccm/policies/section5/5.4012-Policy-Governing-Access-to-and-Use-of-Copyrighted-Works-and-Declaration.pdf

ATTENDANCE DURING INCLEMENT WEATHER:

Titan Alert is the emergency alert system used by CCM to send email, text messages and/or voice phone messages to students, faculty and staff in the event of an emergency or weather-related closing. To see Frequently Asked Questions about Titan Alert and find a link to update your information, go to http://www.ccm.edu/titanfaq.aspx.

Miscellaneous: "Publication" of written work and assignments -- By your continuation in this course and by submitting written assignments and work, you understand that you are granting a limited license to publish that work for the purposes of grading the work. That limited license extends to my submission, within my sole discretion, to various electronic grading tools (e.g., grading books, cite checkers, etc.). College hardware, software and network technology-specific questions are to be directed to IT personnel.

Methods of Evaluation: Course grade is determined as follows:

Mid-Term Exam	20%	
Final Exam	20%	
Quizzes	20%	
Labs	30%	
Participation and Discussion of lectures, labs and readings	10%	(attendance is NOT participation)

The Grading System standard is as published by CCM

Tentative Itinerary
(subject to change as instructor deems necessary)

Week	Topic	Area	Lab/Research
1	1 Computer Abstractions, and Technology	Introduction	Lab setup
2	1 Architectural Components	Performance and Limits	Hello World
3	2 Instructions	Machine and Assembly Languages Translation and Logic	Terminal I/O
4	2	Data Representation	Command Line Args and Program Stack
5	3	Arithmetic Fixed, floating and binary numbers	Number Representation
6	3	Addition and Subtraction	Arithmetic
7	3	Multiplication and Division	Arithmetic (cont'd)
8	**Midterm Exam**	**Topics 1 through 4 (partial)**	**(Oct 20)**
9	4 The Processor	Control, exceptions, design, pipelines	Conditional and Repetition Logic
10	4 CPU Hazards	Pipelining and Efficiency	
11	5 Memory Hierarchy	Memory, Addressing and cache	Conditional and Repetition Logic
12	5 Memory (cont'd)		Procedure Calls and Parsing
13	6 Virtual Machines	Virtualization	File Reading
14	7 Input/Output	Architecture extension via OS Interruption Processing	File Writing
15	**Final Exam**	**Topics 4 (partial) thru 7**	**(Dec 15)**