



ICS 232 Computer Organization and Architecture
Section 01
Metro State University, Summer 2023
4 credits
05/17/2023 - 08/02/2023

Syllabus

Instructor and Department Information

Instructor:	Name:	Robin Ehrlich
	Email:	Robin.Ehrlich@metrostate.edu
	Phone:	
	Office:	
Office Hours:		
Department Information	Name:	Computer Science and Cybersecurity
	Mailing address:	Department of Computer Science and Cybersecurity Metro State University 700 7 th street East Saint Paul, MN, 55106-5000
	Phone:	651-793-1683 (Katie Wilson)

Please note that email is my preferred method of contact and will result in faster responses to you. Be sure to put the course name in the subject line so that I can differentiate between all the different students and other University community members I work with. Remember to use your Metro State email account to avoid your message going to the spam folder.

About the Course

Course Information:	Title:	Computer Organization and Architecture
	Number:	ICS 232
	Section:	01
	Delivery:	Hybrid
	Term:	Summer 2023
	Credits:	4
Class Sessions:	Day:	Wednesday
	Time:	6:00 PM – 9:50 PM

	Location:	https://minnstate.zoom.us/j/97538394199
	Course dates:	5/17/2023 – 8/2/2023
Important Dates:	Last date to drop with full refund:	5/19/2023
	Last date to withdraw:	7/23/2023

Course Description

Introduces machine language, digital logic and circuit design, data representation, conventional von Neumann architecture, instruction sets and formats, addressing, the fetch/execute cycle, memory architectures, I/O architectures, as well as hardware components, such as gates and integrated chips.

Prerequisites

MATH 215: Discrete Mathematics

ICS 141: Programming with Objects or ICS 265: C Programming

Course Learning Outcomes

Upon completion of this course, students will:

Minnesota State Transfer Pathway Learning Outcomes

Required Minimum Competencies

1. Design and implement simple combinational and sequential logic circuits.
2. Represent numeric and text data in current standard formats and convert between numeric formats.
3. Describe instruction execution cycle and how the processor and memory work
4. Describe machine instruction formats and discuss features and differences of instruction set formats and architectures.
5. Write assembly language programs that incorporate standard programming structures, subroutines, I/O and macros.
6. Describe the memory hierarchy including different levels and optimization strategies such as cache and virtual memory.
7. Discuss different I/O and storage devices and mechanisms including bus protocols, interrupts, and interfaces
8. Discuss concurrency techniques to bypass performance bottleneck including pipelining, superscalar, multi-core, and multi-threading
9. List and compare the different architecture categories and describe emerging technologies.

Suggested Content Areas (75-80% or more is expected to overlap with this template)

1. Evolution of computer architecture and influence on development of systems; future trends
2. Boolean algebra and simplification, simple combinational and sequential logic design, and implementation
3. Binary representation of different types of data; numeric data representation including signed and unsigned integers and floating-point formats

4. Basic operation and organization of the Von Neumann machine including CPU, memory, buses, and fetch/execute cycle; Von Neumann bottleneck; memory types and organization; interleaving
5. Machine language concepts and characteristics including instruction formats, addressing modes, RISC versus CISC, and relationship to logic circuits
6. Assembly language programs including standard programming structures, subroutines, I/O and macros; conversion process from higher-level language to assembly language to machine language
7. Storage system concepts, types and operations; characteristics of media formats and tradeoffs; access time, throughput, bandwidth
8. Storage hierarchy pyramid and operation; principle of locality
9. Memory cache concepts and operations; different types of cache including direct, associative, and set associative; write policies and cache coherency in SMP systems
10. Virtual memory techniques and concepts including segmentation and paging
11. I/O: fundamental concepts including handshaking, buffering, programmed I/O, and interrupts
12. Buses: bus protocols, arbitration, and direct-memory access (DMA)
13. Improving performance through superscalar, pipelining, multi-threading, vector processors, GPUs and other concurrent techniques
14. Pipelining operation and hazards; optimization techniques such as branch prediction and speculative and out-of-order execution
15. Flynn's revised taxonomy including SISD, SIMD, MISD, and MIMD; categorize current systems in this taxonomy
16. Quantum computing, neural networks, DNA data storage and other emerging technologies

Text and Supplemental Reading

Textbook and Other Required Reading Materials

The Essentials Of Computer Organization and Architecture by Linda Null - Fifth edition
Assembly Language for Intel-Based Computers by Kip Irvine- Eighth Edition (optional)
C Programming Language, 2nd Edition by Kernighan and Ritchie (optional)

Learning Methods

This course uses a variety of assignments in order to measure student outcomes. In this course you will need to:

- Attend weekly lectures
- Complete homework assignments and project by their due dates

Deliverables and Grading

Assignments and Grading

For many students, computing courses are challenging and computer programming is quite time consuming. I know of no way learn to program without extensive practice, so there will be both reading and programming work to be done outside the class period. The best way to master the subjects is to practice at every opportunity. The amount of time required for each week will vary from individual to individual. It takes time to complete the required reading assignments, homework assignments, and especially the projects. Also, you will need to study for the tests. A typical student will approximately spend the following amount of time: 6 hours per week in assignments, 6 hours per week in reading and studying outside class.

Assignments and grading are in the document schedule.xlsx.

Grade Scale

Percentage	Grade
94 - 100	A
90 - 93	A-
87 - 89	B+
84 - 86	B
80 - 83	B-
76 - 79	C+
72 - 75	C
69 - 71	C-
60 - 68	D
Below 60 %	F

Schedule of Topics and Due Dates

Assignments and grading are in the document schedule.xlsx.

Course Policies

Attendance

In this course you will be practicing problem solving skills. It is strongly recommended that you attend all classes so that you can observe the process of solving computer-based problems from start to finish. I will record the attendance at middle of a class session. The attendance record will have an impact on your final letter grade. You should let your instructor know beforehand if absences are not emergencies and be sure to get notes from one of your classmates and to download the lecture notes posted on D2L.

Note: Federal Financial Aid regulations require that the University track ongoing attendance.

Course Administration

The class is administered using the D2L system supported by Metro State University. To login go to the D2L home page, <https://metrostate.learn.minnstate.edu>.

I will use D2L heavily to distribute class materials and to post assignments, so check D2L often (especially the course landing/announcement page and the course content page). It is your responsibility to find out any changes that I have made regarding the assignments due date, important announcements, and minor schedule changes.

Late Policy for Assignments

All assignments must be submitted prior to the due date. Assignments that are not submitted on time will receive a reduced grade.

Incompletes for Course

Incomplete requests may be accepted if the minimum requirements of the course have been met.

Academic Integrity

The University does not accept knowingly copying the work of others without attribution (plagiarism), or colluding with other students to share answers unless permitted by the instructor (e.g. group project).

You should be aware that the university subscribes to plagiarism detection software, and that your papers may be selected for plagiarism checking. In instances of plagiarism or other forms of academic dishonesty, instructors may impose academic sanctions. Allegations of plagiarism or other forms of academic dishonesty are also subject to investigation and additional conduct sanctions under the [Student Academic Integrity Policy #2190](#), and [Procedure #219: Student Academic Integrity](#).

If you have questions about the use of footnotes or other notations, talk to your instructor, consult the Library and Information Services website, or seek assistance in the proper way of writing a paper by contacting a tutor in the [Center for Academic Excellence](#). Students who believe that they have been falsely accused of plagiarism should request assistance from the Ombudsperson at (651) 793-1517.

Plagiarism and Copyright

Plagiarism is defined as the act of claiming another person's work as one's own. This can be copying or copying even parts of sentences from an article, journal, internet site, another student's

work, or other written work. It can also mean using another student's assignment and making minor changes. Changing a few words around in content is still plagiarism.

Sometimes students are not sure if they are committing plagiarism. Please consult the instructor regarding more information on plagiarism and how to avoid it. The instructor reserves the right to assess through <http://www.turnitin.com/> and/or asking for resources used. Student are encouraged to consult the Metro State University Writing Lab and resources for assistance as well.

If a student is found to have plagiarized work, even if accidentally, the student may be provided a one-time opportunity to redo the assignment. The opportunity to redo the assignment will only be provided one time in the course. Points will be reduced on the revised submission by up to ½ (50%) of the total earned.

The instructor reserves the right to not grant the opportunity to revise and resubmit the assignment. This decision will depend upon the student's overall progress in the course and adherence to course and assignment standards.

Future work that is found to be plagiarized will be given a grade of zero (0). The instructor will notify the student in the feedback for the assignment if work is found to have been plagiarized. If plagiarism occurs repeatedly (even one more time) course failure will result. This policy is consistent with Metro State University Student Handbook and University Procedures.

As part of academic honesty, students are expected to respect intellectual property laws, including copyright law. No parts of this site, your textbook, other publisher materials, or contribution from other class members can be used or distributed outside of this class without the permission of the author(s). Copyright law provides that any creative thought fixed into tangible form is copyrighted the moment it is created, whether or not a copyright notice is affixed.

Please review this excellent article on plagiarism to learn more. Parts of the article are posted below: <https://www.plagiarism.org/article/what-is-plagiarism>

Acts of plagiarism may be reported to the Associate Provost for Student Success.

What you can expect from me

Metro State serves students from many different nations with different racial, ethnic, and religious backgrounds. Students, staff and faculty practice a variety of lifestyles and come from many walks of life. We expect our classrooms to be a place where opinions, practices and beliefs can be expressed without fear. If you feel that you are not being treated appropriately by others in the class, I ask that you bring this to my attention so the issues can be addressed. If I offend you, I ask that you approach me to share your concern so that I can make changes.

If there are issues or questions with the class, please send me an email or talk to me. I will try to respond to emails within 24 hours, but usually much soon.

If you have any issues with me, please talk to me first. If we cannot solve the problem, I will refer you to contact Thanaa Ghanem, chairman of the Department of Information and Computer Sciences, at 651-793-1476 or email to Thanaa.Ghanem@MetroState.edu.

What I expect from you

Please participate in the class fully. Ask questions when I am unclear. If you have a question, it is likely that other may have the same question.

Expectations for Respectful Discussion

All students are encouraged to critically reflect on the course topics and to raise questions to the class and to the professor. Please be respectful to one another by not presenting your question in a hostile manner. Open dialogue on course content is encouraged, but attacks on classmates or myself are not. Please set up a time to talk with me if you have questions about this policy or if you believe this policy is being violated. You may also report hostile or threatening behavior and information about filing a complaint or report can be found here: <https://www.metrostate.edu/students/support/student-concerns-complaints>.

There are many offices on campus that provide additional support and/or information outside of class including:

- Black, African, and African American Support Services:
<https://www.metrostate.edu/students/support/african-and-african-american-student-services>
- American Indian Student Services:
<https://www.metrostate.edu/students/support/american-indian-student-services>
- Asian American Student Services: <https://www.metrostate.edu/students/support/asian-american-student-services>
- Latinx and Undocumented Students Support Services:
<https://www.metrostate.edu/students/support/latinx-undocumented-services>
- LGBTQ Student Services: <https://www.metrostate.edu/students/support/glbtc>
- Veteran Services: <https://www.metrostate.edu/students/support/veterans>
- Women's Support Services: <https://www.metrostate.edu/students/support/women>
- International Student Services: <https://www.metrostate.edu/students/support/international>
- Multicultural, American Indian, and Retention Services:
<https://www.metrostate.edu/students/support/culturally-responsive-support>

University Academic Policies & Information

University Non-Attendance Verification and Reporting Policy and Procedure

The purpose of the Non-Attendance and Reporting Policy is to ensure Federal Title IV regulations are adhered to with respect to a student's enrollment level for the purpose of calculating and paying financial aid. While Metro State University is not required to take attendance, Federal Title IV financial aid regulations require a procedure to establish that students have attended, at a minimum, one day of class for each course in which the student's enrollment status was used to determine eligibility for the Pell Grant Program. In addition, the university needs to determine a last date of attendance for those students who receive all failing grades or unofficially withdraw. Attendance is defined based on course delivery mode. A student is "in attendance" if he or she meets the following conditions before the end of the second week of the course:

- Classroom Courses –the student is present in the classroom.
- Web-Enhanced (Reduced Seat Time Courses) –the student is present in the classroom or submits at least one academically relevant assignment.
- Online Courses –the student submits at least one academically relevant assignment.
- Independent Studies – the student contacts the instructor or submits at least one academically relevant assignment

If a student does not attend the first two classes, either live and/or online, that student is automatically dropped from the course. If a student adds the course past the drop/add date, he/she will not receive points for any assignments, discussions, quizzes, or exams for which the due date has already occurred.

Refer to the [Non-Attendance and Reporting Policy 2259](#), and the [Non-Attendance and Reporting Procedure 259](#).

Diversity and Disability Statement

Our institution values diversity and inclusion; we are committed to a climate of mutual respect and full participation. Our goal is to create learning environments that are usable, equitable, inclusive and welcoming. If there are aspects of the instruction or design of this course that result in barriers to your inclusion or accurate assessment or achievement, please notify the instructor as soon as possible. Students with disabilities are also welcome to contact the Center for Accessibility Resources to discuss a range of options to removing barriers in the course, including accommodations.

Phone: 651-793-1549

Web: Center for Accessibility Resources

The University provides access to its programs and services by making reasonable accommodations for qualified students. Accommodations may include approval for early registration, note-takers, interpreters for the deaf, adaptive equipment, and testing arrangements.

Student Code of Conduct

Students at Metro State University deserve the opportunity to pursue an education, and it is the responsibility of the university to provide an environment that promotes learning and protects the safety and well-being of the university community. Therefore, the university establishes this Student Conduct Code. Any action by a student that interferes with the education of any other student or interferes with the operations of the university in carrying out its responsibility to provide an education will be considered a violation of this code.

The Student Code of Conduct balances individual student due process rights with the broader interests of the safety, wellbeing and academic integrity of the university community. The Dean of Students Office administers the student conduct process at Metro State University. It operates with the philosophy of balancing the need for student accountability with the opportunity for education and making amends. Students are encouraged to review the [Student Conduct Code University Policy #1020](#) and the [Student Conduct Code Procedure #112](#) to understand their rights and responsibilities under the Code.

If you are aware of a potential student conduct violation, you may report it [HERE](#). If you are not certain and would like to inquire about whether something falls under the Student Code of Conduct, please email dean.students@metrostate.edu.

Sexual Violence, Sexual Harassment, and other Gender Related Discrimination Concerns

If you believe you have experienced sexual misconduct, harassment, or violence and would like the university to formally investigate the situation, you may submit a formal complaint. These complaints can be student to student, employee to student, employee to employee, and non-students or non-employees.

Information about student(s) involved or investigation itself are confidential and protected under Family Educational Rights and Privacy Act (FERPA). However, information about instances of sexual misconduct must be shared among university staff whose are investigating the situation and responsibilities for rendering a decision.

Students who have experienced or observed related issues may submit a report [HERE](#). If you are certain if something falls within this category, you may email dean.students@metrostate.edu . Additionally, the Dean of Students and other related offices provide training and education on these important issues.

Email

Metro State University has designated e-mail as an official method of communication with students. **The university expects** students to be responsible for all information sent to them via their official university email account. Refer to [Policy 1050, University E-mail](#), for further information.

Academic Appeals

The university has written procedures for appealing decisions concerning grades. You should first attempt to resolve an appeal issue informally with the instructor. To file a formal appeal, you must begin the formal appeal process within 60 calendar days of the posting of the grade or evaluation. A staff member in Student Affairs serves as ombudsperson to work with students in preparing formal appeals. For details, refer to [Procedure 202, Academic Appeal Procedure](#).

University Policy on Academic Progress

The university's academic progress policy may affect students who withdraw from classes. Be aware that a W (withdraw) is different from a drop. A drop occurs at the very beginning of the term (no later than January 14 for this course), while a withdraw occurs after the first week. Withdrawing from this class may put you at risk for academic probation. If you have questions about your situation, contact your academic advisor as soon as possible.

Technology Requirements and Expectations

Technical Assistance

IT Helpdesk (it.desk@metrostate.edu; 651-793-1240) provides general computer assistance.

Center for Online Learning (online.learning@metrostate.edu; 651-793-1650) provides general assistance with online learning and course access. Please include your tech id number and course name and number.

Computer Hardware and Software

For this course, your computer must fully pass the System Check found on the [D2L login page](#).

Students must have internet access in order to log into the D2L system multiple times per week in order to check for updates and complete required work. Your skills should include the ability to add browser plug-ins for viewing files and content presented within the course or be able to get such assistance from non-campus sources at your own expense.

File Management

Intermediate or higher level skills at file management (ability to create folders, move and rename folders and files, identify type of file by its file-extension, attach files to emails, etc.)

Anti-Virus Software

Updated virus scanning software for all files sent and received (such as McAfee Antivirus, Norton Internet Security, etc.) is required.

Computer Software

Computer skills include proficiency with using a web browser and in using the Internet to access online resources and sites as well as competence at using Microsoft Office products such as Word and Power Point.

Email

Metro State University has designated e-mail as an official method of communication with students. **The university expects** students to be responsible for all information sent to them via their official university email account. Refer to [Policy 1050, University E-mail](#), for further information.

This course requires students to use their campus email account for all communication for related to this class. Emails originating from outside the campus email servers may accidentally be blocked as spam. This policy prevents viruses and spam. Please include in the subject line of your emails a brief description that summarizes the content of the email.

Additional Resources for Student Support

Technical Assistance

IT Helpdesk (it.desk@metrostate.edu; 651-793-1240) provides general computer assistance.

Center for Online Learning (online.learning@metrostate.edu; 651-793-1650) provides general assistance with online learning and course access. Please include your tech id number and course name and number.

Accessibility Resources **(REQUIRED FOR ALL SYLLABI)**

Phone: 651-793-1549

Web: [Center for Accessibility Resources](#)

The University provides access to its programs and services by making reasonable accommodations for qualified students. Accommodations may include approval for early registration, note-takers, interpreters for the deaf, adaptive equipment, and testing arrangements.

TRIO Student Support Services

Support for first-generation students, low-income students and students with disabilities. They can be reached at trio.center@metrostate.edu or 651-793-1525.

Center for Academic Excellence—Tutoring and Testing Center

Phone: 651-793-1461

Web: [Center for Academic Excellence](#)

Email: centerfolk@metrostate.edu

Our tutoring mission: to help students learn. We strive to role-model resourcefulness, active learning, and collaborative problem-solving, such that students build self-confidence and efficacy as independent life-long learners. Our professional and peer tutors help students navigate conceptual difficulties and develop study skills. Our tutors are devoted to helping currently-enrolled students achieve their academic goals in one-to-one and small group tutorials.

Students are encouraged to contact the Center for Academic Excellence first for their tutoring needs. Metro State students also can access tutoring through tutor.com which is provided through Minnesota State (each student can get 15 hours of tutoring from tutor.com).

To access this service:

- Sign into D2L
- At the very top there is a menu bar: click on Tutor.com
- You can work with a tutor immediately or schedule a session
- Under Topic: select [Subject].
- Under Subject: select the relevant level or course topic

Collegiate Recovery Program

Phone: 651-793-1579 (Dean of Student's Office)

Web: [Collegiate Recovery Program](#)

Metro State University's Collegiate Recovery Program provides support and resources for students who have challenges with substance use or other behavioral addictions. We also support students working toward long-term recovery to increase overall well-being and meet educational, professional and personal goals. For general information or questions, you may email at Collegiate.Recovery@metrostate.edu.

Counseling Services

Phone: 651-793-1568

Web: [Counseling Services](#)

College students often experience issues that may interfere with academic success, such as academic stress, sleep problems, balancing multiple responsibilities, life events, relationship difficulties, discrimination / oppression, or feelings of anxiety, hopelessness, or depression. If you are a friend is struggling, we encourage you to seek support. Helpful, effective, and culturally-responsive services are available on campus free of charge.

For immediate help during or after hours, on weekends and holidays, contact Counseling Services at 651-793-1568 and choose option zero to access the Metro CARES support line. Counseling Services is providing telehealth services to students during the COVID-19 pandemic. To schedule an appointment with our staff counselors, call 651-793-1568 during business hours.

International Student Services

Phone: 651-793-1315
Web: [International Student Services](#)

The International Student Services (ISS) aids with immigration, cultural, financial, academic, and personal issues for international students at Metro State University.

Library and Information Services

Phone: 651-793-1616
Web: [Library and Information Services](#)
Email: library.services@metrostate.edu

The Library and Learning Center on the Saint Paul campus offers a full array of library resources, services, computers, and study spaces for the Metro State University community. Librarians are available to assist you in finding information on virtually any topic. They can also guide you in evaluating scholarly and other resources for your coursework and research. Assistance is available by phone (651-7983-1614), email (library.services@metrostate.edu), or chat and Zoom from the library's homepage. Through this homepage you can access more than 100 research databases and thousands of ejournals, streaming videos, and ebooks.

Multicultural, American Indian and Retention Services (MAIR)

Phone: 651-793-1543
Web: [Multicultural Success Services](#)

Founder's Hall, St. Paul Campus

MAIR promotes the academic success of historically underrepresented incoming, current and graduating students by providing retention programming and a wide range of services that includes advocacy and educational planning. MAIR department comprises of the following student services: American Indian, Indigenous, Asian, Asian American and Native Pacific Islander, Black, African and African American, Latinx and Undocumented, Veterans and Military Student Services Center, and Women's & LGBTQ+ Student Services and Resources. MAIR Success Coordinators provide coaching, educational and belonging services: holistic individual success plans, cultural events that highlight Metro State University's diversity, equity and inclusion, special brave/courageous spaces for student groups: Native Circle, Women's and LGBTQ+ Student Resource Center, and Veterans and Military Student Services Center. Also, Success Coordinators

advise student clubs and organizations such as Black Student Union, Hmong Student Organization, Lavender Bridge, Metro State University's Veterans Network, Pueblo, and Voices of Indian Council for Educational Success (VOICES). Success Coordinators provide support to empower students and promote successful college transitions and graduation.

Student Parent & Resource Center

Phone: 651-793-1564
Web: [Student Parent & Resource Center](#)
St. John's Hall, L.14; St. Paul Campus

The Student Parent Center is in St. John's Hall L14 and provides a child-friendly study space (visit our website for updates regarding availability of the space). The center seeks to provide support and connect currently enrolled students and their families with campus and community resources to ease obstacles that may be interfering with their education. Students can schedule a phone or Zoom appointment to meet with the coordinator here: <https://calendly.com/studentparentresourcecoordinator/60min>

Food for Thought Food Pantry

Phone: 651- 793-1571
Web: [Food for Thought Food Pantry](#)
St. John's Hall, L.10; St. Paul Campus

The Food for Thought Food Pantry is a collaborative initiative between Metro State University and our community partners Good in the Hood and Every Meal. Students seeking additional support with subsidizing their food budget can schedule an appointment to pick-up free prepackaged food boxes and bags from the library. Please visit our website for changes and updates regarding the operations of the pantry. Schedule an appointment to pick-up food here: <https://calendly.com/foodforthoughtpantry/food-for-thought-food-pantry-pick-up>.

Veterans & Military Student Services

Phone: 651-793-1561
Web: [Veteran Services](#)
Founder's Hall 201, St. Paul Campus

We assist all who have served or are currently serving in any branch of the United States Armed Forces. Veterans Services will advocate on your behalf. We provide help with understanding admissions requirements and academic programs, getting college credits for your military training, accessing federal and state educational and financial benefits, and VA certification of your registered courses. Thank you for your dedication, sacrifice, and service to our country.

Women's and LGBTQ+ Student Services and Resources

Phone: 651-793-1544

Web: [Women's and LGBTQ+](#)

Founder's Hall, Room 140, St. Paul Campus

Women's and LGBTQ Student Services fosters a safer and more inclusive campus by providing support, resources, leadership development, and education related to diverse sexual orientations and gender identities. Metro State University supports a large contingent of LGBTQ+ students and there are multiple services and resources available. To help foster a safer and more inclusive campus, the center has confidential resources and information available for those who experience discrimination based on sex, gender identity, or sexual orientation

Zoom

As part of being a student within the Minnesota State Colleges and Universities System, you have access to a premium license of the web conferencing tool: Zoom. Due to recent events your instructors will likely be using this more frequently to host class sessions online, but you can also personally use it for meetings with your classmates!

You can access your MinnState Zoom account from: <https://minnstate.zoom.us/>, just click the "Sign on" button and login with your StarID and password.

Visit the following link to learn more about connecting to a Zoom conference:
<https://services.metrostate.edu/TDClient/1839/Portal/KB/ArticleDet?ID=101232>

Visit the following link to learn more about hosting a Zoom conference for presenting or teaching:
<https://services.metrostate.edu/TDClient/1839/Portal/KB/ArticleDet?ID=100273>

If you get stuck or need some extra help, you can reach out to our Information Technology Services or the Center for Online Learning.

Also, the [Zoom Help Center](#) has many great resources, live trainings, and even fantastic technical support representatives waiting to help you if need-be.