

Course Syllabus

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CSE 381: Systems 2

GENERAL INFORMATION

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Class location & Hours:

- Section A
- Mon: **10:05 AM to 11:55 AM (EST)** in **Benton 010 (Mac Lab)**
 - Wed, Fri: **10:05 AM to 11:00 AM (EST)** in **Upham 002**
- Section B
- Tue: **10:05 AM to 11:55 AM (EST)** in **Benton 010 (Mac Lab)**
 - Wed, Fri: **10:05 AM to 11:00 AM (EST)** in **Upham 002**

Instructor:

Dhananjai M. Rao ( [Listen to pronunciation](#) [_ \(http://pc2lab.cec.miamioh.edu/img/rao.wav\) _](http://pc2lab.cec.miamioh.edu/img/rao.wav))

Office: 205S Benton Hall

Email: raodm@miamiOH.edu (<mailto:raodm@miamiOH.edu>)

URL: <http://www.users.miamioh.edu/raodm/> [_ \(http://www.users.miamioh.edu/raodm/\) _](http://www.users.miamioh.edu/raodm/)

Lab: [Parallel and Cloud Computing Laboratory \(PC2 Lab\)](#) [_ \(http://pc2lab.cec.miamiOH.edu/\) _](http://pc2lab.cec.miamiOH.edu/)

Online help For seeking help or clarifying questions on homework and lab exercises always start with the discussion forums on Canvas. The discussion forums should be your first step for seeking help electronically.

Scheduled Tue: 1:00 pm to 2:00 pm (EST)

office hours: Wed: 12:00 pm to 1:00 pm (EST)

Fri: 1:00 pm to 2:00 pm (EST)

By Send me an email 24 hours in advance to set up an appointment. Unless you receive an **Appointment:** acknowledgment from me, do not assume that the meeting is set up.

Open door If you stop by and if I am not busy, I will gladly help you and answer your questions.
policy:

Teaching Assistant(s):

Ensure you read the [University policy and legal recourse information](#) further below in this syllabus to understand the roles of TAs. **In general, all late submissions and grading questions must be directed to your instructor and never to your TA.**

List of Teaching Assistants:

- Ryan Moore
- Sam Cain
- Wei Lisi

Teaching Assistant(s) Office Hours:

- Tentative: Mondays and Tuesday 6 pm to 8 pm in Ben 010

Note: TAs are not available for private tutoring sessions or for private meetings for help. Setup such requests/appointments with Dr. Rao instead.

Prerequisites:

1. CSE 278: Systems 1 (intro. to networking & databases important)
2. Good knowledge of C++ programming under Linux. It is highly recommended students complete CSE-278 (System 1) prior to taking this course.
3. Working with Linux at the command prompt
4. Good technical writing skills, including creating charts and graphs.
5. Familiarity with general computing concepts and terminology
6. Excellent knowledge of using online resources, websites, manuals, etc.

Official Communication:

All the official communication in this class will be performed electronically in the following 2 primary forms:

- Canvas will be the primary mechanism for announcements, schedule changes, and other information that pertains to the whole class
- Via your MU email address only (to ensure compliance with FERPA guidelines). It is your responsibility to check your MU email often, every day.

Note regarding help via email

I will stop providing help via **emails** for homework assignments and other exercises 24 hours prior to their due dates. If you have questions in the last 24 hours, you must meet me in-person during office hours.

Important Dates:

Event	Date
Last date to drop this course: (no grade on transcript)	Fri, Sep 14 2018
Last date to withdraw from course ("W" on transcript)	Monday, Oct 29 2018

Last day of class:	Fri Dec 7 2018
Exam 1:	Thu, Oct 4 (Time: 7 PM to 9 PM)
Exam 2:	Thu, Nov 8 (Time: 7 PM to 9 PM)
Final Exam:	Friday, Dec 14 2018 (10:15 AM to 12:15 PM) Room: Upham 002

Textbook:

- **"Operating System Concepts"** by Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. 8th Edition. John Wiley & Sons, July 29, 2008 (ISBN: 978-0-470-12872-5). [On-campus link to Safari E-book](http://proquest.safaribooksonline.com/9780470128725) (<http://proquest.safaribooksonline.com/9780470128725>), [Off-campus link to Safari E-book](http://proquest.safaribooksonline.com.proxy.lib.miamioh.edu/9780470128725) (<http://proquest.safaribooksonline.com.proxy.lib.miamioh.edu/9780470128725>). You are not required to own a hard copy of the textbook, but you can purchase a hard copy if you find it more convenient to use than the e-book.

Strongly recommended IDE:

- **NetBeans IDE 8.2** from Oracle Inc. is the recommended IDE for this course. It can be freely downloaded from <https://netbeans.org/downloads/> (<https://netbeans.org/downloads/>). You also need to install Miami University customization plugin from and configure NetBeans as shown in the following links:

Additional References:

- **"C++ How to Program" (Tenth Edition)** by Paul Deitel and Harvey Deitel. Pearson. February 29 2016 (ISBN-10: 0-13-444893-6, ISBN-13: 978-0-13-444893-0). [On-campus link to Safari E-book](http://proquest.safaribooksonline.com/9780134448930) (<http://proquest.safaribooksonline.com/9780134448930>), [Off-campus link to Safari E-book](http://proquest.safaribooksonline.com.proxy.lib.miamioh.edu/9780134448930) (<http://proquest.safaribooksonline.com.proxy.lib.miamioh.edu/9780134448930>).
- **"C++ Concurrency in Action: Practical Multithreading"** by Anthony Williams. Manning Publications. February 28 2012 (ISBN-10: 1-933988-77-0, ISBN-13: 978-1-933988-77-1). [On-campus link to Safari E-book](http://proquest.safaribooksonline.com/9781933988-771) (<http://proquest.safaribooksonline.com/9781933988-771>), [Off-campus link to Safari E-book](http://proquest.safaribooksonline.com.proxy.lib.miamioh.edu/9781933988-771) (<http://proquest.safaribooksonline.com.proxy.lib.miamioh.edu/9781933988-771>).
- Other reference materials posted off the course web site. The course may use multimedia materials including videos. Therefore please be prepared to deal with standard web-based technologies.

COURSE POLICIES

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Grade distribution:

This class includes a variety of exercise designed to facilitate your understanding of systems programming. The course includes several homework assignments some of which most will be programming assignments.

The grade distribution for the various categories is shown in the table below:

Category	Weight
In-class & Lab Exercises	10%
Homework & In-class (Pop) Quizzes	40%
Exam 1	15%
Exam 2	15%
Final Exam:	20%

Grade scale:

Your final letter-grade in this course will be determined as shown in the table below. Note that, **there will be no grade curving!**

Weighted Score	Grade	Weighted Score	Grade	Weighted Score	Grade
97-100	A+	93-96.99	A	90-92.99	A-
88-90	B+	83-87.99	B	80-82.99	B-
78-80	C+	73-77.99	C	70-72.99	C-
68-70	D+	63-67.99	D	60-62.99	D-
0-59.99	F				

Attendance Policy:

- Attendance is required for every class and lab.
- You are expected to be on time for every class and/or lab.
- You are expected to focus on course materials and not cause unnecessary distractions that may disrupt the class experience for other students. Consequently, use of extraneous electronic devices during lecture or lab is prohibited.
- 🚫 A cumulative absence of 3 or more days (lectures and labs combined) may result in being dropped from the course even if drop/withdraw deadlines have elapsed.
- **Excused Absence:** In case of a planned absence or an unplanned absence due to health issues:
 - Inform your instructor beforehand whenever possible.
 - Medical excuses require written documentation from your physician indicating the nature of the illness and the duration of ailment submitted to the Dean's office.
 - Submit on time any work that is due.
 - Understand that there are no make-ups for missed labs, quizzes, exams or other in-class work. The missed in-class work will be marked with a zero score and will impact your final grades.

- **Weather & Other Emergency Closing:** In case of an unplanned weather or another emergency closing, all the policies and procedures of the University will be followed, as stipulated in [Emergency Procedures](http://miamioh.edu/campus-safety/emergency-procedures/) (<http://miamioh.edu/campus-safety/emergency-procedures/>). It is your responsibility to track emergency notifications from the University to determine if classes are canceled. University policy does not excuse missing even one class due to weather issues near your residence or travel route. Consequently, when classes are not canceled by the University but you have a weather emergency near your residence, then use your discretion on attending while noting that it is not an excused absence (as per University policy) and any in-class work will be marked with a zero score.

Interacting with TAs & graders:

Your course may include TAs or graders who will work with your instructor to provide you with the best educational experience and all the support possible to help you succeed in the course. However, it is imperative to remember the following important protocols when interacting with TAs:


- The TAs maybe your friends outside the class settings. However, in all aspects directly or indirectly related to the course they to be treated as if they were your instructor.
- **It is important to remember that the TAs/graders are employees of Miami University. Therefore, they have legal protection (and obligations that go with it) from the University and they can seek legal recourse for any forms of discrimination or untoward conduct.**
- The role of the TAs/graders is to help you learn. They are clearly instructed not to provide solutions. Consequently, asking the TA "Can you give me the answer to this question?" violates ethical conduct expected of you. Instead, the question should be "Can you help me find resources to learn and answer this question?"
- The TAs/graders do not have any role in policy matters, due dates, deadlines, grade disputes etc. If a question does not solicit help, you should not be sending them to a TA/grader. For example, emailed delayed submission to a TA violates ethical conduct expected from you.

Policies for Lab Exercise & (Pop) Quizzes:

The course will consist of a combination of lectures and laboratory-style experiments. Lab exercises are to be completed during the 75 minutes. They are not homework. In addition, short quizzes or other exercises will be performed during routine class hours. The quizzes will most likely be pop-quizzes and will not be announced in advance. **There is no makeup for in-class exercises and quizzes**. If you miss one you get a zero for it. All in-class quizzes are to be individual work. No reference materials or discussions will be permitted. Unless stated otherwise, use of electronic devices during quizzes is prohibited.

Policies for Homework:

Most of the homework will require designing and implementing programs. In addition, several programming exercises will require performance evaluation and report writing about the programs. Furthermore, certain homework may require additional reading and writing essays. The following policies will be strictly followed for all homework:

- **General Policies:**
 - Cannot be turned in late.
 -  Starting early is critical for successfully completing the homework.
 - Work alone. You may help one another but without sharing any code.
 - Use the Canvas online discussion forums in for a homework to seek general clarifications or help to troubleshoot a specific compiler error.
 - All programs must adhere to good programming practices, style (see [CSE Programming Style Guide](http://miamioh.edu/cec/academics/departments/cse/academics/programming-style/index.html) (<http://miamioh.edu/cec/academics/departments/cse/academics/programming-style/index.html>)), and use good documentation suitable for a particular language.
- **Coding standards:** All programs must adhere to good programming practices, particularly:
 1. Coding practices (see [CSE Programming Style Guidelines](http://miamioh.edu/cec/academics/departments/cse/academics/programming-style/index.html) (<http://miamioh.edu/cec/academics/departments/cse/academics/programming-style/index.html>)) will be enforced in the course using automatic scripts.
 2. Use good documentation suitable for a particular language.
 3. Must contain a design that is clear and concise.
- **Late submission:** Delayed submissions of homework assignment **will not be accepted**, unless:
 - You have documented medical reasons clearly explaining the reason for missing deadlines. In the case of medical issues, you must meet with me in-person, preferably with a doctor's note, and discuss the situation.
 - You have documented evidence indicating death or funeral in your family.
- **Grading rubric:** The following grading rubric will be adopted for all programming assignments in addition to any other rubrics specified with each assignment:
 - Failure to comply with turn-in procedures or file naming conventions will not be tolerated and will be assigned a zero score.
 - Programs that do not even compile or link will be assigned zero score.
 - **Programs and scripts that do not operate correctly for stipulated base-case inputs (if any) will be assigned a zero grade!**
 - For programs that do meet the above requirements, I will try to fix bugs and correct them. For every correction that I make, however subtle may it be, you will lose 10% for every line of source code changed. A line of source code will be determined based on the formatting requirements stipulated by the programming language and the CSE Programming Style guidelines.
- **Outside Help:** Discussion of course related material is encouraged. However, sharing of assignments and/or answers is strictly prohibited. Students are expected to use good judgment with regard to receiving outside help. Programs that are essentially identical are considered to be the work of another, and will be treated as academic dishonesty. Please refer to the [Miami Student Handbook](http://www.miami.muohio.edu/documents_and_policies/handbook/) (http://www.miami.muohio.edu/documents_and_policies/handbook/) for a detailed description of student expectations.
- **Help via Emails:** I will provide help and direction for programming projects via email. However, the following policy applies for obtaining help via email for homework related issues:

- I will stop providing help via emails **24 hours before the final deadline**. During the last 24 hours, you have to meet me in person (either during office hours or through appointment) to get help to troubleshoot your program.
- Response to emails received after business hours (8-5), during holidays, and weekends will be sporadic.
- **Checkpoint submissions:** Intermediate submission of homework solutions may be expected (all homework may not have this requirement). Due dates for checkpoint submissions will be indicated along with each homework assignment.
 - Checkpoints must include cumulative journal entries. That is you must preserve earlier entries in the journal and add new ones for each checkpoint. Journal entries must describe the progress made along with any problems you faced or overcame.
 - Source code in checkpoints must compile but need not be complete or defect free.
 - For every checkpoint submission deadline missed, you will lose 25% of the grade for the homework assignment.
 - This policy will be rigorously pursued in this class.

Exam Policies:

- **General Policies:** Two exams and a final exam will be administered for this course. The only acceptable excuse for missing the scheduled exam and to request makeup exam is that it conflicts with another course. I will excuse only those for whom there is no other alternative. Begin to arrange your schedule now (work, meetings, interviews, etc.). If you require a makeup exam, you must obtain written (via email) permission from me prior to the test. Unexcused, missed exams will be recorded with zero points.

The exams will be closed book and closed-notes. The only electronic device permitted during exams is a scientific calculator. The calculator cannot have a "qwerty" keyboard, graphical screen, wired or wireless communication ports. However, electronic devices for life support or medical equipment will be permitted when appropriate documentation is provided.

- **Makeup Exams:** Requesting makeup exams/quizzes is discouraged and will be allowed only under the following extraordinary circumstances:
 1. An unexpected, documented medical emergency arises
 2. Provable extenuating circumstances.

Note, that makeup exams are not guaranteed and require a legitimate, documented reason. In all cases, students are responsible for informing the instructor no later than 24 hours prior to a scheduled exam.

- **Final Exam Policy:** The University policy for the final exam is that no exam may be administered early except with written permission from the Associate Dean of the division. **This permission is typically not given except under extraordinary circumstances.**

In-Class Participation:

- **In-class Exercise:** Unless otherwise stated, all in-class exercise are to be individual work. However, you are permitted to discuss aspects of the exercise with your neighbors in class. Appropriately helping your neighbor without affecting your own performance is desired.
- **Preparation:** You are expected to closely track the class progress and review the materials before and after each class.
- **👉 Taking Notes:** I use in-class electronic presentations to give you some basic information. These are not a substitute for taking notes.
 - Take notes during lectures. Taking notes helps to reinforce core concepts for the course.
 - Lab activities will often depend on you to use what you wrote in the lecture.
 - Good notes can have a positive impact on your grade.
 - "Good notes" does not mean "Write everything". Be selective.
 - Focus on writing sample code, diagrams, "notes to self".

COURSE OBJECTIVES AND OUTCOMES

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Catalog Description:

Introduction to operating systems concepts. The operating system as a resource manager. The principles for the design and implementation of operating systems. Process scheduling and deadlock prevention. Memory management, virtual memory, paging, and segmentation. Interrupt processing. Device management, I/O systems and I/O processing. Concurrency and multithreading. Virtualization and cloud services. Security and protection.

Course Objectives:

At the end of this course, students will be able to:

- Carry out the key steps involved in loading and starting an operating system
- Critique the design and tradeoffs in file systems and computer memory hierarchy and their interfaces
- Use Multiprocessing and Inter-Process Communication (IPC) concepts and tools including pipes to monitor and control processes
- Use Concurrency and Multithreaded programming concepts to create processes with multiple cooperating threads in ways that avoid deadlock and livelock.
- Describe the use of virtualization and cloud services in effective ways
- Describe the use of various security features provided by an operating system to avoid common security problems such as buffer overflows, stack smashing, trojans, and root kit problems.

List of Main Topics:

Here is a brief overview of the main topics to be covered in this course. A more detailed description of the course content is available off the [CSE website](http://miamioh.edu/cec/academics/departments/cse/academics/course-descriptions/cse-381/index.html)

(<http://miamioh.edu/cec/academics/departments/cse/academics/course-descriptions/cse-381/index.html>).

- Processes
- Inter-Process Communication (IPC)
- Multithreading
- Synchronization and deadlocks
- Virtualization & Security
- Review of C++ programming language and the Linux environment

TENTATIVE SCHEDULE

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
Here is a tentative schedule for this course. I will suitably pace the course as the semester progresses.













- **Week 1 [Aug 27]: Introduction**
 - Introduction to class room environment and policies.
 - Introduction to Linux environment and working at the bash shell prompt.
 - Review of relevant Systems 1 concepts and C++ programming
- **Week 2 [Sept 3]: Processes in OS**
 - Review of processes
 - Process life cycles and hierarchies
 - Creating and managing processes
 - I/O streams and processes
- **Week 3 [Sept 10]: Operating system concepts**
 - Basic roles of an operating system as a resource manager and extended machine
 - The concept of BIOS
 - Basics of Boot loaders
 - Basic concept of a device driver
 - Introduction to system calls
 - Using strace to observe system calls
- **Week 4 [Sept 17]: Operating system concepts (contd.)**
 - Survey of different types of operating systems and operating modes
 - Batch processing vs. multitasking
 - Interactive vs. noninteractive
 - Preemptive vs. nonpreemptive multitasking
 - Desktop vs. embedded
 - Real time operating systems
 - Exploring the clone/fork system call to clone a process
 - Disambiguation between parent and child processes
 - Replacing program in a running process using execl family of system calls.
 - Understanding exit codes

- **Week 5 [Sept 24]: Inter-process communication (IPC)**
 - Introduction to IPC
 - Review of various approaches for accomplishing IPC including: pipes, shared memory, message queues, and sockets
 - Pipes for IPC
 - Generic pipes via the shell
 - Anonymous pipes via system calls
- **Week 6 [Oct 1]: IPC, Networking, and Web-servers**
 - Inter-Process Communication (IPC) over TCP sockets
 - Review of web-servers and HTTP protocol
 - **Exam 1: Thu Oct 4**
- **Week 7 [Oct 8]: Multithreading in OS**
 - Concurrency, processes, and threads
 - Processes vs. threads
 - Creating threads in C++
- **Week 8 [Oct 15]: Threads synchronization**
 - Synchronizing concurrent threads
 - Critical sections
 - Mutexes in
- **Week 9 [Oct 22]: Multi-threaded web-server and Deadlocks**
 - Designing a multi-threaded web-server
 - Deadlock Characterization
 - Deadlock Prevention
 - Deadlock avoidance
- **Week 10 [Oct 29]: Basics of Memory Management**
 - Paging
 - Segmentation
 - Virtual memory
- **Week 11 [Nov 5]: Virtualization, cloud computing, & Security**
 - Running running custom operating system using qemu
 - Create custom initramfs using busybox to rollout custom linux distribution
 - Introduction to hardware virtualization and cloud computing
 - Overview of cloud computing platforms
 - Infrastructure as a Service (IaaS)
 - Platform as a Service (PaaS)
 - Software as a Service (SaaS)
 - **Exam 2: Thu Nov 8**
- **Week 12 [Nov 12]: File Systems**
 - Need for a file system
 - Use of a file system driver
 - Links in file systems
 - File permissions in Linux review

- Hard links & Symbolic links
- **Week 13 [Nov 26]: File Systems (Contd.)**
 - File system in user space
- **Week 14 [Dec 3]: Review and reprise (Contd.)**
 - Review course materials for final exam.
 - Complete surveys.

Course Summary:

Date	Details	
Wed Aug 29, 2018	 Exercise #1: Linux review & Icebreaker (https://miamioh.instructure.com/courses/75955/assignments/812982)	due by 11:59pm
Mon Sep 10, 2018	 Homework #1: Programming concepts review (https://miamioh.instructure.com/courses/75955/assignments/834203)	due by 11:59pm
Wed Sep 12, 2018	 Exercise #2 Part A: Basic I/O in C++ (https://miamioh.instructure.com/courses/75955/assignments/838424)	due by 11:59pm
	 Exercise #2 Part B: Debugging & Type aliases (https://miamioh.instructure.com/courses/75955/assignments/838533)	due by 11:59pm
Mon Sep 17, 2018	 Homework #2 Part A: Basic OS concepts (https://miamioh.instructure.com/courses/75955/assignments/839434)	due by 11:59pm
Tue Sep 18, 2018	 Homework #2 Part B: gid processing (https://miamioh.instructure.com/courses/75955/assignments/839424)	due by 11:59pm
Wed Sep 19, 2018	 Exercise #3: Processes & Syscalls (https://miamioh.instructure.com/courses/75955/assignments/842700)	due by 11:59pm
Mon Sep 24, 2018	 Homework #3 Part A: Processes, Fork, & Exec (https://miamioh.instructure.com/courses/75955/assignments/843863)	due by 11:59pm
Tue Sep 25, 2018	 Homework #3 Part B: Print process tree (https://miamioh.instructure.com/courses/75955/assignments/843864)	due by 11:59pm
Wed Sep 26, 2018	 Exercise #4: Fork & Exec (https://miamioh.instructure.com/courses/75955/assignments/845960)	due by 11:59pm
Wed Oct 3, 2018	 Exercise #5: Exam Practice (https://miamioh.instructure.com/courses/75955/assignments/849140)	due by 11:59pm

Date	Details	
Thu Oct 4, 2018	 Midterm Exam #1 (https://miamioh.instructure.com/courses/75955/assignments/852256)	due by 11:59pm
Wed Oct 10, 2018	 Exercise #6: Feedback & Pipes (https://miamioh.instructure.com/courses/75955/assignments/852625)	due by 11:59pm
Mon Oct 15, 2018	 Homework #4 Part A: IPC & Pipes (https://miamioh.instructure.com/courses/75955/assignments/853196)	due by 11:59pm
Tue Oct 16, 2018	 Homework #4 Part B: Custom shell (https://miamioh.instructure.com/courses/75955/assignments/853142)	due by 11:59pm
Wed Oct 17, 2018	 Exercise #7: Pipe programming & Basic Networking (https://miamioh.instructure.com/courses/75955/assignments/856005)	due by 11:59pm
Tue Oct 23, 2018	 Homework #5: Pipes & HTTP (https://miamioh.instructure.com/courses/75955/assignments/857184)	due by 11:59pm
Wed Oct 24, 2018	 Exercise #8: Networking & Threads (https://miamioh.instructure.com/courses/75955/assignments/859794)	due by 11:59pm
Wed Oct 31, 2018	 Exercise #9: Threading & Mutex (https://miamioh.instructure.com/courses/75955/assignments/863906)	due by 11:59pm
	 Homework #6: Multithreading (https://miamioh.instructure.com/courses/75955/assignments/860343)	due by 11:59pm
Wed Nov 7, 2018	 Exercise #10: Exam2 Practice (https://miamioh.instructure.com/courses/75955/assignments/867422)	due by 11:59pm
Thu Nov 8, 2018	 Midterm Exam #2 (https://miamioh.instructure.com/courses/75955/assignments/865383)	due by 11:59pm
Wed Nov 14, 2018	 Exercise #11: File systems (https://miamioh.instructure.com/courses/75955/assignments/870652)	due by 11:59pm