# SER334: Operating Systems and System Programming Syllabus

*To the reader: please be aware that this course may be substantially more difficult than previous ones you have taken. Previous students have reported that it is a "humbling" experience.*

## Catalog Description

Fundamentals of operating systems: run-time environments, process management, scheduling, synchronization techniques, memory management, and file management. Introduces programming concepts and tools for developing operating system modules, system utilities, and low-level applications in POSIX environments.

## General Information:

| Instructor | Pranut Jain, pjain26@asu.edu |
|---|---|
| **Office Hours** | Appointment-based - please send an email or DM on Slack to schedule a time. |
| **Class Meeting Time** | Online |
| **Schedule Line Number** | 169524 |
| **Class Website** | Canvas, GitHub, YouTube |
| **Communication** | Slack: TBD |
| **Final Exam Date** | TBD |

| Course Coordinator | racuna1@asu.edu, (480) 727-1580 (email preferred) |
|---|---|
| **Office Hours** | Ground: Peralta Hall 230Q, online: https://zoom.us/my/acuna. |
| | The base course shell was developed by Ruben Acuña, faculty lecturer. All questions regarding course material and grading must be directed to the instructor for your section of the course. |

## Enrollment Requirements:

**Prerequisites:**
- SER222: Design & Analysis: Data Structures & Algorithms (corequisite; C or better if completed)
- CSE230: Computer Organization / Assembly Language Programming (with C or better)
- CSE240: Introduction to Programming Languages (with C or better)

It is your responsibility to know the background material defined by the outcomes of these courses. If you did not take these courses recently (as defined by the SE major map), or you did not do well when you took them, you will need to spend time to review the material.

# Course Objectives:

The outcomes of this course are the following:

|  | Course Outcome | Program Outcome |
|---|---|---|
| CO-1 | Construct programs such as operating system modules, system utilities, and low-level applications which use POSIX libraries such as threading and file management. | PO-SER1 |
| CO-2 | Describe and distinguish operating system concepts in run-time environments, process management, scheduling, synchronization techniques, memory management, and file management. | PO1 |
| CO-3 | Describe and simulate algorithms and mechanisms in operating systems including processor schedulers, synchronization tools, memory allocation, and disk scheduling. | PO1 |
| CO-4 | Analyze operating system design problems, design a solution, and articulate justification for their solution. | PO1 |

# Course Structure:

The material in this course is separated into modules. Most modules correspond to one chapter from the textbook. Each week typically covers two or three modules. Each module is comprised of instruction (videos, sample problems), followed by an exercise (to cement the concepts), and a homework assignment (to really practice). Most assignments are programming. **You are expected to engage with course using the following flow: Instruction →Exercise →Homework.**

Time to complete a module varies, but it is typically nine hours to complete instruction, exercise, and homework. Modules without a programming assignment will take considerably less time because programming is intensive. You are encouraged to do load balancing between the modules that require lots of time, and those that require less.
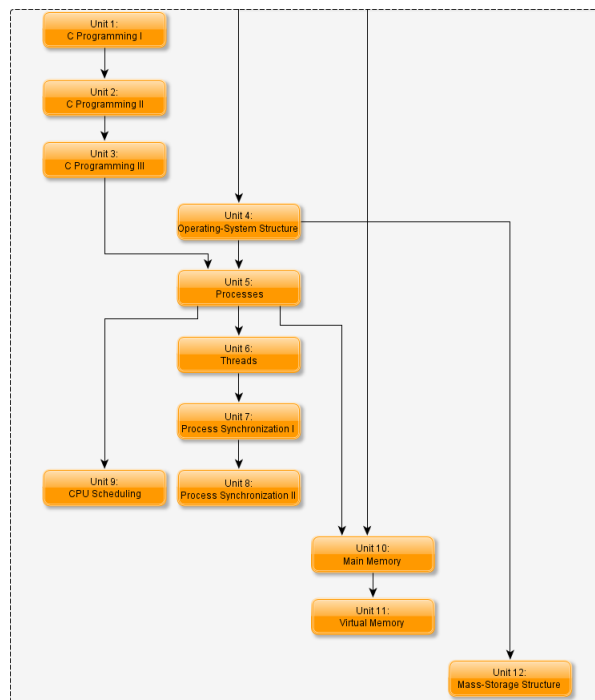
## Course Materials:

<u>Readings:</u> The required text is: A. Silberschatz, P. B. Galvin, G. Gagne, *Operating System Concepts,* 9th edition or 10th edition, Wiley. If you're interested in other books on operating systems, the instructor can make recommendations. A used copy of the text is acceptable.

# Other:

**Communication:** This class uses a communication tool called Slack to manage course communications. Please make Slack the first place you look for new information regarding the course. It is expected you will check Slack at least once every day, as will the instructional staff each evening. Do not expect that we will be on Slack at other times, though we may occasionally pop-in to provide help and see how you are doing. Staff will be accessible synchronously on Slack as stated on the Contact Information page in Canvas. For email and Slack messages, please allow 24 to 48 <u>business</u> hours for a response.

- **Canvas Note: do not use the comment feature on any submission (e.g., short answer or programming). We do not use it because Canvas does not have a way to track what has been answered.** Use Slack or email if you have questions.
- **Do not share any answers (even if partial) to graded assignments on Slack until after the due date.** For example, do not post a code snippet of your homework that you have questions on. If we see this, we will delete your post and contact you personally. Instead, you should 1) Post your question without code (e.g., "I get a null pointer exception when displaying the list, any ideas?"), or 2) Reach out to the instructional staff who can privately provide input on your work.

**Academic Calendar:** Please review ASU's Academic Calendar (https://students.asu.edu/academic-calendar) for important Registrar dates such as: adding/ dropping/ withdrawing from courses, etc.

**Late Homework Policy:** All homework is due at 11:59:00pm (Arizona Time). ***<u>Late submissions are not accepted, except as defined under Late Pass below.</u>*** Students choosing to submit on the

final day of the deadline are responsible for any personal technical issues (including but not limited to: computer, internet, Canvas) that occur. Students are encouraged to submit homework several days in advance of any deadline. It is also highly suggested that students double check that they have submitted the correct files - students will receive a grade based on what they submitted. Extensions are permitted only when there is a significant, and documented, event (e.g., illness or personal emergency) that prevents the student from completing the assignment. A notice must be submitted to the instructor before the due date or as soon as circumstances allow.

**Late Pass:** A late pass grants an extension of upto 24 hours to a module's homework. You have TWO (2) late passes that you may use during the semester. To use a late pass, add a comment to your submission on Canvas that you are using a late pass for this homework. Due to logistics, the late pass may NOT be applied to homework for Module 12. Multiple late passes may not be applied to the same assignment.

**Supplemental Instruction:** This course was selected to participate in ASU's Supplemental Instruction (SI) program. SI sessions are group study opportunities, scheduled 2-3 times per week. These sessions are facilitated by your SI Leader, who is attending class and preparing SI sessions based on the course content. Students should attend SI sessions to ask questions about course content, work collaboratively with other students, and to develop learning/study strategies. Students who participate in SI sessions typically earn higher final course grades and exam grades than students who do not participate in SI. SI attendance is voluntary, and it is not a substitute for class attendance. For information about the days, times, and Zoom links for SI sessions, refer to the SI website: https://tutoring.asu.edu/content/supplemental-instruction-si-schedule.

## Grading:

Performance will be assessed by homework, exercises, and three exams. Their (tentative) weights are:

| | Exercise | HW: Program | ADJ | Exam |
|---|---|---|---|---|
| Unit 0: Introduction | 15 | | | |
| Unit 1: C Programming I | 14 | 28 | | |
| Unit 2: C Programming II | 14 | 30 | | |
| Unit 3: C Programming III | 14 | 41 | | |
| Unit 4: Operating-System Structures | 14 | | | |
| Exam 1 | | | | 150 |
| Unit 5: Processes | 14 | 36 | | |
| Unit 6: Threads | 14 | 54 | | |
| Unit 7: Process Synchronization I | 14 | | 80 | |
| Unit 8: Process Synchronization II | 14 | 40 | | |
| Exam 2 | | | | 150 |
| Unit 9: CPU Scheduling | 14 | 36 | | |
| Unit 10: Main Memory | 14 | | | |
| Unit 11: Virtual Memory | 14 | 36 | | |
| Unit 12: Mass-Storage Structure | 14 | | | |
| Exam 3 | | | | 150 |
| **Subtotal:** | 169+14 | 301 | 80 | 450 |
| **Total: 1000 + 14 (EC)** | | | | |

The final letter grade will be determined according to the points obtained as follows:

| E | D | C | C+ | B- | B | B+ | A- | A | A+ |
|---|---|---|----|----|---|----|----|---|----|
| 0-599 | 600-699 | 700-769 | 770-799 | 800-829 | 830-869 | 870-899 | 900-929 | 930-969 | 970-1000 |

**Homework Drops:** No homework will be dropped.

**Extra Credit:** The course includes an extra exercise (14 points) as part of the standard course schedule. Any points earned will be directly added to your score. These extra points serve either as a way to increase your overall course grade, or they enable skipping an exercise.

**Exercise Policies:** Exercises should be completed as you finish the instruction in the course. They have a relatively low weight and are graded more leniently so they can be used to develop your skills without worrying as much about your final grade. Treat them as an opportunity to try applying concepts before doing heavily weighted homework, and receive quick feedback in terms of a solution. Assuming you paid attention during the videos, exercises will not take more than 75 minutes to complete. **No exercise questions require a compiler or doing online research** - in fact, doing either of those things may hinder your learning experiences. You should figure out things on your own, or by asking us questions to steer you in the right direction. Exercises are graded with higher level of granularity than homework. For each question:
- 0% points for did not attempt or extremely low effort (e.g., clearly didn't pay attention in lecture, irrelevant answers, copy/paste text from any source (with attribution), etc.)
- 50% points if answer is good try but not correct or complete
- 100% point if answer is correct or very nearly correct.

For each exercise, click the "Submit Quiz" button when you have completed all the questions. **Only one submission is allowed**, no second attempts for any reason. **Solutions will be after the due date.**

**Programming Homework Policies:** Read the PDF file on the Homework page on Canvas for specifics on what your programming submissions should look like. In addition:
- Double check your submissions to ensure they contain source files (e.g., .c) and that every file requested is attached. Your submission file(s) will be put in a folder with the base files attached to the assignment - there is no need to resubmit them.
- Do not use the "submission comment" feature when submitting source file. If you have any remarks about the homework, send the instructor an email or put them in your source code.
- You are allowed unlimited submissions, **only the newest submission will be graded.** If you try to view the homework after submitting it from the Homework page rather than My Grades, you may cause a new submission to be made. This will override your proper submission! *__No late submissions are accepted.__*

Standard programming deductions (see HW standards PDF on Canvas):
- If your program fails to compile out-of-the-box, we will deduct 20% from the graded total.
- If you do not follow the file submission standards (e.g., the submission contains project files, lacks a proper header), we will deduct 10% off of the graded total.

## Grade Appeals:

Students may appeal a scored assessment within three days of grades being released. Appeals are in email form only and must point to specific evidence of why the grade should be revised. The instructor reserves the right to assign a lower score on appeal. For additional information on ASU's grade appeal policy, see https://catalog.asu.edu/appeal.

## Absence Polices:

Students unable to take exams, or complete assignments due to a medical condition must present a doctor's signed excuse and notify the instructor as soon as the condition affects the student's work.

Accommodations will be made for religious observances provided that students *notify the instructor at the beginning of the semester concerning those dates*. Students who expect to miss class due to officially university-sanctioned activities should *inform the instructor early in the semester*. Alternative arrangements will generally be made for any examinations and other graded in-class work affected by such absences. The conditions under which assigned work and/or tests can be made up, include: a) Excused absences related to religious observances/practices that are in accord with https://www.asu.edu/aad/manuals/acd/acd304-04.html, "Accommodation for Religious Practices". b) Excused absences related to university sanctioned events/activities that are in accord with https://www.asu.edu/aad/manuals/acd/acd304-02.html, "Missed Classes Due to University-Sanctioned Activities". c) Excused absences related to missed class due to military line-of-duty activities that are in accord with https://www.asu.edu/aad/manuals/acd/acd304-11.html, "Missed Class Due to Military Line-of-Duty Activities," and SSM 201-18, "Accommodating Active Duty Military".

Per SSM 201-02, an instructor may drop a face to face student for nonattendance during the first week of the semester. For an online course, a drop may be initiated for students who do not log into the course shell during the first week.

## Faculty recording of class sessions

Note that class sessions may be recorded (or broadcast live) to accommodate students with ASU documented need, and recordings provided to those students. If you have concerns about being recorded, please contact the course instructor.

## Classroom Behavior:

**As of 8/18/21, ASU's Face covering policy (https://www.asu.edu/about/fall-2021#face-coverings) states: "...face coverings will be required in certain indoor settings, i.e., where distancing may not be possible. These include the following: Classrooms and teaching or research labs where distancing is not possible." Based on the number of students enrolled, social distancing will not be possible, therefore wearing a mask will be required.**

Cell phones must be on silent during class to avoid causing distractions. Exceptions may be accommodated for personal reasons with advance approval of the instructor. The use of recording devices is NOT permitted during class.

Students are expected to participate in the educational process and not be a disruptive element with regard to the learning of others. Safety, self-discipline and respect for others are necessary elements in the educational processes employed in this course. All students should be familiar with the Student Code of Conduct, which can be found at http://www.asu.edu/studentlife/judicial/ .

## Academic Integrity:

Students in this class must adhere to ASU's academic integrity policy, which can be found at https://provost.asu.edu/academic-integrity/policy). Students are responsible for reviewing this policy and understanding each of the areas in which academic dishonesty can occur. In addition, all engineering students are expected to adhere to the ASU Academic Integrity Honor Code. All academic integrity violations will be reported to the Fulton Schools of Engineering Academic Integrity Office (AIO). The AIO maintains record of all violations and has access to academic integrity violations committed in all other ASU college/schools.

Specific academic integrity rules for this class are: The Student Academic Integrity Policy of Arizona State University requires each student to act with honesty and integrity and to respect the rights of others in carrying out all academic assignments. There are a number of actions that constitute a violation of the policy. These actions in this course include, but are not limited to:

1) practicing any form of academic deceit;

2) referring to materials or sources or employing devices (e.g., audio recorders, crib sheets, calculators, solution manuals, or commercial research services) not specifically authorized by the instructor for use during tests, quizzes, homework, and class activities;

3) acting as a substitute for another person in any academic evaluation or using a substitute in any academic evaluation;

4) possessing, buying, selling, or otherwise obtaining or using, without appropriate authorization, a copy of any materials intended to be used for academic evaluation in advance of its administration;

5) depending on the aid of others to the extent that the work is not representative of the student's abilities, knowing or having good reason to believe that this aid is not authorized by the instructor;

6) providing inappropriate aid to another person, knowing or having good reason to believe the aid is not authorized by the instructor;

7) submitting the ideas or work of another person or persons without customary and proper acknowledgment of sources (i.e., engaging in plagiarism);

8) permitting one's own ideas or work to be submitted by another person without the instructor's authorization; or attempting to influence or change any academic evaluation or record for reasons having no relevance to class achievement.

9) turning in work/code done by someone else or another pair/group

10) copying work/code done by someone else or another pair/group

11) writing code together with someone else or with another pair/group (unless expressly allowed by the instructor)

A common question in programming courses is the use of code that is "googled" or found on popular sites such as StackOverflow. Items 5 and 7 pertain to this situation. Most programmers use reference examples, found in print or online. This is fine as a practice but is not acceptable in situations where you are using code to proxy your understanding of the coding concepts applied in that assessment (i.e. lab or in-class activity). First, if you are uncertain if it is allowable or not, verify directly with the instructor before submitting the assignment. Second, if it is allowable, you are still required to a) adhere to all originating author's constraints on the use and licensing of the code, and b) provide proper attribution (full URL to the code snippet or bibliographic reference to a print item). Failure to do so constitutes a violation of this Academic Integrity Policy.

Students may be allowed to work in small teams on lab and in-class assessments. You are to work with your partners and only your partners as directed by the instructor; receiving assistance from anyone else other than your partners, the graders, teaching assistants, approved tutors or the instructor is considered a violation of this Academic Integrity Policy. Further, on any paired/group assessments you remain individually responsible for the entire solution - you must understand it fully, and there will be no differentiated grades awarded between the individuals in the pair/group. From an ethics standpoint, you have a professional responsibility to your partner to give your best effort on each programming assignment. Failure to do so will be considered an ethics violation.

The penalty for an Academic Integrity Violation (cheating) on an in-class assessment or lab will be a reduction of a course letter grade for the first offense, and failure of the course for a second offense. The penalty for an Academic Integrity Violation (cheating) on an exam is immediate failure of the course. The penalty for an ethics violation will be a zero for the in-class assessment or lab. All violations will be referred to the Dean's Office of the Ira A. Fulton Schools of Engineering.

**Students should not release (to GitHub, friends, etc.) any of their completed assignments, in order to ensure that they do not cause an AIP violation during a future semester. If a student in a later class submits your work, you and they will be held accountable.**

## Copyright:

You must refrain from uploading to any course shell, discussion board, or website used by the course instructor or other course forum, material that is not the student's original work, unless the student first complies with all applicable copyright laws; faculty members reserve the right to delete materials on the grounds of suspected copyright infringement.

All course content and materials, including lectures (Zoom recorded lectures included), are copyrighted materials and students may not share outside the class, upload to online websites not approved by the instructor, sell, or distribute course content or notes taken during the conduct of the course (see ACD 304-065-308 F.14 for more information).

You may not post any course material (including but not limited to slides, exercises, and assignments), even excerpts, to an external site without the instructor's written permission. If this occurs, you may be penalized for Academic Dishonesty or IP infringement.

## Policy against threatening behavior, per the Student Services Manual, SSM 104-02:

Students, faculty, staff, and other individuals do not have an unqualified right of access to university grounds, property, or services (see SSM 104-02). Interfering with the peaceful conduct of university-related business or activities or remaining on campus grounds after a request to leave may be considered a crime. All incidents and allegations of violent or threatening conduct by an ASU student (whether on- or off-campus) must be reported to the ASU Police Department (ASU PD) and the Office of the Dean of Students.

## Warning of Offensive Class Materials

Some content in this course may be deemed offensive by some students. If you find any material objectionable you may consult with the instructor or your Program Chair to identify appropriate accommodations.

## Disability Accommodations:

Suitable accommodations will be made for students having disabilities. Students needing accommodations must register with the ASU Student Accessibility and Inclusive Learning Services office and provide documentation of that registration to the instructor. Students should communicate the need for an accommodation in sufficient time for it to be properly arranged. See ACD 304-08 Classroom and Testing Accommodations for Students with Disabilities.

## Harassment and Sexual Discrimination:

Arizona State University is committed to providing an environment free of discrimination, harassment, or retaliation for the entire university community, including all students, faculty members, staff employees, and guests. ASU expressly prohibits discrimination, harassment, and retaliation by employees, students, contractors, or agents of the university based on any protected status: race, color, religion, sex, national origin, age, disability, veteran status, sexual orientation, gender identity, and genetic information.

Title IX is a federal law that provides that no person be excluded on the basis of sex from participation in, be denied benefits of, or be subjected to discrimination under any education program or activity. Both

Title IX and university policy make clear that sexual violence and harassment based on sex is prohibited. An individual who believes they have been subjected to sexual violence or harassed on the basis of sex can seek support, including counseling and academic support, from the university. If you or someone you know has been harassed on the basis of sex or sexually assaulted, you can find information and resources at https://sexualviolenceprevention.asu.edu/faqs.

As a mandated reporter, I am obligated to report any information I become aware of regarding alleged acts of sexual discrimination, including sexual violence and dating violence. ASU Counseling Services, https://eoss.asu.edu/counseling is available if you wish to discuss any concerns confidentially and privately. ASU online students may access 360 Life Services, https://goto.asuonline.asu.edu/success/online-resources.html.

## Change Notice:

Any information in this syllabus may be subject to change with reasonable advance notice.

# Schedule

In this course, we will be covering approximately ten chapters from Silberschatz (skipping a few sections here and there). **Keep in mind that this is not a fixed schedule and topics/assignments may change. The schedule is tentative.**

| Day | Topic |
| --- | --- |
| (1) | *No class!* |
| (1) | Syllabus, Introduction |
| (2) | M1: C Programming I - Sample Problems |
| (2) | M1: C Programming I - |
| (2) | M1: C Programming I - |
| (3) | *Holiday Buffer* |
| (3) | M2: C Programming II - |
| (3) | M2: C Programming II - |
| (4) | M2: C Programming II - |
| (4) | M3: C Programming III - |
| (4) | M3: C Programming III - |
| (5) | M3: C Programming III - |
| (5) | M4: OS Structures - |
| (5) | M4: OS Structures - |
| (6) | ***Exam 1 (tentative)*** |
| (6) | M4: OS Structures - |
| (6) | M5: Processes - |
| (7) | M5: Processes - |
| (7) | M5: Processes - |
| (7) | M6: Threads - |
| (8) | M6: Threads - |
| (8) | M6: Threads - |
| (8) | *No class - Wonderbread Day Observed!* |
| (9) | *Holiday Buffer* |
| (9) | M7: Process Synchronization I - |
| (9) | ***Exam 2 (tentative)*** |
| (10) | M7: Process Synchronization I - |
| (10) | M7: Process Synchronization I - |
| (10) | M8: Process Synchronization II - |
| (11) | M8: Process Synchronization II - |
| (11) | M8: Process Synchronization II - |
| (11) | M9: CPU Scheduling - |
| (12) | M9: CPU Scheduling - |
| (12) | M9: CPU Scheduling - |
| (12) | M10: Main Memory - |
| (13) | *Holiday Buffer* |
| (13) | ***Exam 3 (tentative)*** |
| (13) | M10: Main Memory - |
| (14) | M10: Main Memory - |
| (14) | M11: Virtual Memory - |
| (14) | M11: Virtual Memory - |

| Day | Topic |
| --- | --- |
| (15) | M11: Virtual Memory - |
| (15) | M12: Mass-Storage Structure - |
| (15) | *No class - Thanksgiving Observed!* |
| (16) | M12: Mass-Storage Structure - |
| (16) | M12: Mass-Storage Structure - |
| (16) | TBD - Buffer |
| (17) | ***Exam 4*** |