

**San José State University**  
**Computer Science Department**  
**CS149, Operating Systems, Section 3, Spring 2023**

**Course and Contact Information**

Instructor(s): William “Bill” Andreopoulos

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Office Hours: Wednesday 13:30-14:30 (MH 416), Friday 14:00-15:30 (Zoom)

Class Days/Time: Monday and Wednesday, 12:00pm-13:15pm

Classroom: DH 450

Prerequisites: CS146 (Data Structures and Algorithms) and CS47 or CMPE102 with a grade of C- or better

**Faculty Web Page and MYSJSU Messaging**

Course materials such as syllabus, handouts, notes, assignment instructions, etc. can be found on Canvas Learning Management System course login website at <http://sjsu.instructure.com>. You are responsible for regularly checking with the Canvas messaging system to learn of any updates. You should modify the Canvas settings for notifications of announcements and discussion forum postings to be sent to you.

**Course Description**

Fundamentals: Contiguous and non-contiguous memory management; processor scheduling and interrupts; concurrent, mutually exclusive, synchronized and deadlocked processes; files. Substantial programming project required. Prerequisite: CS 146 or SE 146 (with a grade of "C-" or better). Computer Science, Applied and Computational Math or Software Engineering Majors only; or Instructor Consent.

**Course Learning Outcomes (CLO)**

Upon successful completion of this course, students will be able to:

- CLO 1 Understand the role that the operating system software plays in the management of the various hardware subsystems of the computer system.
- CLO 2 Understand locality of memory reference and how it is used to perform effective memory hierarchy management.
- CLO 3 Understand the various mapping, replacement, and dynamic allocation algorithms for cache and virtual memory management.
- CLO 4 Understand the alternative CPU scheduling schemes, their tradeoffs, and their applications to other queue processing situations.
- CLO 5 Appreciate the difficult tradeoffs faced when attempting to deal with the resource deadlock problem and distinguish between the different deadlock prevention and avoidance schemes and understand why and how deadlocks can still happen today.
- CLO 6 Understand software race conditions, their origin and the problems they can cause, along with knowing how to apply semaphores in software design to solve the race condition problem.

CLO 7 Understand the various issues associated with the operating system's role in performing I/O and file management.

## Required Texts/Readings

### Textbooks

Remzi H. Arpaci-Dusseau, Andrea C. Arpaci-Dusseau. Operating Systems: Three Easy Pieces. (*OSTEP*)

**This book is available online:** <http://pages.cs.wisc.edu/~remzi/OSTEP/>

### Other Readings

- W. Richard Stevens, Stephen A. Rago. Advanced Programming in the UNIX Environment - 3rd Edition, 2013, Addison-Wesley. (APUE)
- Robert Love. Linux Kernel Development - 3rd Edition, 2010, Addison-Wesley. (LKD)
- A. Silberschatz, P. Galvin, and G. Gagne. Operating System Concepts - 9th Edition, 2012, Wiley. <http://www.os-book.com/>
- Handouts through Canvas.

### Other technology requirements / equipment / material

In this class we will use Ubuntu as our programming environment for homework assignments – see Canvas for details to install it. We will use a C compiler for programming assignments. Unless otherwise stated, all homework assignments should compile and run on the particular Ubuntu and C version, which is explained on a Canvas page.

Integrated Development Environment for C - different students prefer to use different IDEs or even text editors. You can choose from visual studio, eclipse, or cLion. You can also work in vi or nano and do the compilation on the command line.

zyBooks – We will also use zyBooks for practicing C programming in-class. You can follow 3 steps to subscribe, as described on Canvas.

## Course Requirements and Assignments

SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on.

**Reading assignments:** Readings will regularly be assigned for the next class (see schedule). Slides will be posted under the Canvas modules before the next class.

**Worksheets:** There will be worksheets with problem solving. These will generally involve coding problems (in C or bash) from the reading assignment or similar to the homework. The worksheets are a tool for you to learn the material, prepare for exams and practice coding for your future job interviews. These should be submitted on Canvas.

The worksheets are graded based on effort and get graded "complete" if a reasonable solution is proposed for each problem. It is understood that a worksheet solution might be imperfect.

A worksheet submission is due approximately every week. The worksheet submission page on Canvas closes after it is due. Please submit what you have by the due date.

We will take time at the beginning of each class to discuss any difficulties students have in completing the worksheets from previous classes. We will also do code reviews.

**Homework assignments:** Programming assignments will be assigned. More information will be given at the time of the first programming assignment. Late penalty is 2% per day up to 15 days; after 15 days no submission will be accepted and the submission page will be closed.

Students have the option to work with a partner in groups of two on the worksheet or assignment solutions. If two students form a group, the pair of both group members will get the same grade for any worksheet/assignment they submit together. *Only one group member should submit a worksheet/assignment to avoid double grading. If you work with a partner, you must put your group members' names in a spreadsheet that will be given. Partners must write both of their names in the Canvas comment box for each worksheet or assignment submission (5% penalty if you forget to show both names in the submission comment box).* Students may leave a group, or work on their own if they prefer. Note it is optional to work with a partner.

While it is fine to discuss the worksheet/assignment solutions with your partner within your group, code solutions submitted on Canvas should reflect the students' own efforts in writing the code. *Do not write the code for anyone else. Never copy any code you find on another source, such as a website. Canvas automatically checks submissions for plagiarism from multiple online sources.* Oral examination might be requested.

All homework should be uploaded to Canvas under the proper submission page. If you send your homework via an email or message it will not be graded.

**Participation during class via Zoom:** The polling questions are in the form of multiple-choice and true-false questions. All students are expected to participate with Zoom polling. Credit is given based on participation and it is not necessary to get the correct answer in polls to get credit. Please contact eCampus at [ecampus@sjsu.edu](mailto:ecampus@sjsu.edu) with any questions or issues with the Zoom technology.

**Midterm exams:** There will be two Midterm exams during the semester.

**Final exam:** One final cumulative exam.

The exams will contain multiple choice questions, true/false and short answer questions. Exams are closed book, closed notes, and comprehensive. Exams are in-person unless there are extraordinary circumstances, in which case they will require access to the internet, Canvas, Lockdown Browser (on Windows or macOS machine), and Respondus Monitor (web camera). The exams should be done individually. No make-up exams except in case of verifiable emergency circumstances.

### **Extra credit opportunities**

A student can volunteer to present his/her solution for an assignment or a worksheet in-class (either via Zoom or in person). These will take the form of code reviews, where the student walks us through his/her code solution for an assignment or a worksheet, we discuss the proposed solution and if there are better ways to solve the problem. A code review lasts for 10 minutes max. Extra credit of 1% is given to a student who reviews their code solution for an assignment or a worksheet. Students have to add their name to a code review worksheet to reserve a code review timeslot. An assignment or worksheet can only be reviewed once. A student may reserve one timeslot at a time. If, after presenting, there are other timeslots available, a student may reserve another timeslot.

At the end of the semester the professor will select up to 3 students who throughout the semester frequently offered the most helpful and insightful answers in the discussion forum and offer them 1% extra credit.

There may be a bonus assignment worth 2%.

### **Determination of Grades**

Final Grade is based on:

- 50% Assignments
- 20% Midterms (10% each)
- 20% Final
- 9% Worksheets
- 1% Participation (Zoom attendance)

<i>Grade</i>	<i>Points</i>	<i>Percentage</i>	<i>Interpretation</i>
<i>A plus</i>	<i>960 to 1000</i>	<i>96 to 100%</i>	<i>Exceptional</i>
<i>A</i>	<i>930 to 959</i>	<i>93 to 95%</i>	<i>Excellent</i>
<i>A minus</i>	<i>900 to 929</i>	<i>90 to 92%</i>	<i>Very good</i>
<i>B plus</i>	<i>860 to 899</i>	<i>86 to 89 %</i>	<i>Good</i>
<i>B</i>	<i>830 to 859</i>	<i>83 to 85%</i>	<i>Fair</i>
<i>B minus</i>	<i>800 to 829</i>	<i>80 to 82%</i>	<i>Fair</i>
<i>C plus</i>	<i>760 to 799</i>	<i>76 to 79%</i>	<i>Passed</i>
<i>C</i>	<i>730 to 759</i>	<i>73 to 75%</i>	<i>Passed</i>
<i>C minus</i>	<i>700 to 729</i>	<i>70 to 72%</i>	<i>Barely passed</i>

<i>D plus</i>	<i>660 to 699</i>	<i>66 to 69%</i>	<i>Fail</i>
<i>D</i>	<i>630 to 659</i>	<i>63 to 65%</i>	<i>Fail</i>
<i>D minus</i>	<i>600 to 629</i>	<i>60 to 62%</i>	<i>Fail</i>

## Communication with the instructor

Students should follow the correct channels for communication. Questions should preferably be done during the regular class meeting time via Zoom or office hours. For course-related electronic communication students should use the Discord channel:

1) We will be using the course Discord channel for class discussion. The system is catered to getting you help efficiently from classmates, the TA, embedded tutor, and the instructor. Rather than emailing redundant questions to the teaching staff, students should post questions on the Discord channel where the entire class can read and benefit from the responses. The professor may re-post questions that are of general interest to the general channel or discuss them in class. The professor may ask students to reveal their real name if they are making special requests on Discord (e.g. deadline extensions) to prevent abuse.

2) Students are invited to join the office hours.

*Private messages sent to the instructor's other email addresses get lost due to the large volume of emails received.*

The instructor does not write messages after normal business hours, on weekends or holidays.

Reviewing code for the homework and technical trouble-shooting should be done during the office hours.

Never email your entire code for an assignment to the instructor. The instructor will not fix all the bugs in your code. Limit the code you post to 20 lines or less.

Announcements that concern everyone, such as reminders about due dates or class policy, will be posted.

## Embedded Tutor

None this semester

## Graders/TAs

Sriya Balineni [sriya.balineni@sjsu.edu](mailto:sriya.balineni@sjsu.edu)

## Class Attendance

Attendance (in-person or via Zoom) is highly recommended. Classes will be recorded as Zoom screencasts and posted on Canvas. Students are responsible for all material presented in all classes.

## Regrading Procedure

Grades assigned are final, unless there was an error in the grading. If a student wants to request a regrade of a homework or test, please follow instructions on the "Regrade request" page on Canvas. A request for a regrade is not a technique to drum up a few more points. If the course instructor thinks a component was scored too

generously the first time, it may be lowered in a regrade. Thus, regrading may result in a lower grade. Students who request a regrade for a higher grade are expected to also be pursuing the extra credit opportunities offered.

## **Classroom Protocol**

Students on Zoom should be muted when not speaking, and dressed appropriately when their camera is on.

Course material developed by the instructor is the intellectual property of the instructor. Students can not publicly share or upload instructor generated material for this course such as exam questions, lecture notes, hands-on exercises or homework solutions without instructor permission.

## **Add/Drop Policy**

For those wishing to add this course, the deadline is February 20, 2023. The last day to drop a course without a “W” grade is February 20, 2023. To drop after this date, a Late Drop petition will be required. According to University and Department guidelines, dropping after February 20, 2023, requires a serious and compelling reason to drop a course. Grades alone do not constitute a reason to drop a course. Students who stop attending without officially dropping will be issued a “U” at the end of the semester which is counted as an F in calculations of GPA.

Students are responsible for understanding the policies and procedures about add/drop, grade forgiveness, etc. Refer to the current semester's Catalog Policies section at <http://info.sjsu.edu/static/catalog/policies.html> . Add/drop deadlines can be found on the current academic year calendars document on the Academic Calendars webpage at [http://www.sjsu.edu/provost/services/academic\\_calendars/](http://www.sjsu.edu/provost/services/academic_calendars/) . The Late Drop Policy is available at <http://www.sjsu.edu/aars/policies/latedrops/policy/> . Students should be aware of the current deadlines and penalties for dropping classes. Information about the latest changes and news is available at the Advising Hub at <http://www.sjsu.edu/advising/>.

## **Consent for Recording of Class and Public Sharing of Instructor Material**

University Policy S12-7, <http://www.sjsu.edu/senate/docs/S12-7.pdf> , requires students to obtain instructor's permission to record the course. Common courtesy and professional behavior dictate that you notify someone when you are recording him/her. You must obtain the instructor's permission to make audio or video recordings in this class. Such permission allows the recordings to be used for your private, study purposes only. The recordings are the intellectual property of the instructor; you have not been given any rights to reproduce or distribute the material.

Course material developed by the instructor is the intellectual property of the instructor and cannot be shared publicly without his/her approval. You may not publicly share or upload instructor-generated material for this course such as exam questions, lecture notes, hands-on exercises or homework solutions without instructor consent.

## **Academic Integrity**

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University Academic Integrity Policy S07-2 at <http://www.sjsu.edu/senate/docs/S07-2.pdf> requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at <http://www.sjsu.edu/studentconduct/> . Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments

are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Integrity Policy S07-2 requires approval of instructors.

- Anyone caught cheating (including sharing answers with others during exams) in the class will receive a failing grade on the exam or assignment, in addition to other sanctions that are permitted by the University, including but not limited to the filing of a report with the Dean of Student Services and expulsion from the University.

### **Campus Policy in Compliance with the American Disabilities Act**

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 at [http://www.sjsu.edu/president/docs/directives/PD\\_1997-03.pdf](http://www.sjsu.edu/president/docs/directives/PD_1997-03.pdf) requires that students with disabilities requesting accommodations must register with the Accessible Education Center (AEC) at <http://www.sjsu.edu/aec> to establish a record of their disability.

In 2013, the Disability Resource Center changed its name to be known as the Accessible Education Center, to incorporate a philosophy of accessible education for students with disabilities. The new name change reflects the broad scope of attention and support to SJSU students with disabilities and the University's continued advocacy and commitment to increasing accessibility and inclusivity on campus.

### **University Policies**

Per University Policy S16-9, university-wide policy information relevant to all courses, such as academic integrity, accommodations, etc. will be available on Office of Graduate and Undergraduate Programs' Syllabus Information [web page](http://www.sjsu.edu/gup/syllabusinfo/) at <http://www.sjsu.edu/gup/syllabusinfo/>

## **CS149 Operating Systems, Section 3, Spring 2023**

The schedule is subject to change with fair notice.

### **Course Schedule**

<b>Week</b>	<b>Topic</b>
<b>01/25</b>	Introduction
<b>01/30</b>	Review C and the command line
<b>02/01</b>	Review C and the command line
<b>02/06</b>	Review C and the command line

<b>02/08</b>	Review C and the command line
<b>02/13</b>	Processes
<b>02/15</b>	Process API
<b>02/20</b>	Interprocess Communication, Sockets, Pipes

<b>02/22</b>	System calls with File I/O
<b>02/27</b>	Signals
<b>03/01</b>	<b>Midterm 1</b>
<b>03/06</b>	CPU Scheduling
<b>03/08</b>	Multilevel CPU Scheduling
<b>03/13</b>	Direct Execution
<b>03/15</b>	Address Space
<b>03/20</b>	Memory API
<b>03/22</b>	Free-Space Management
<b>03/27- 03/31</b>	<i>Spring recess</i>
<b>04/03</b>	Paging
<b>04/05</b>	Swapping Policies
<b>04/10</b>	Thread API
<b>04/12</b>	Locks
<b>04/17</b>	Lock-based concurrent Data Structures
<b>04/19</b>	<b>Midterm 2</b>
<b>04/24</b>	Condition Variables and Semaphores
<b>04/26</b>	Concurrency Bugs
<b>05/01</b>	Advanced Locks
<b>05/03</b>	Hard Disks
<b>05/08</b>	Files and Directories
<b>05/10</b>	File System Implementations
<b>05/15</b>	Review, wrap-up
	<b>Final exam on Wednesday, May 17, 9:45am-12:00pm</b>