Cmp Sci 4760 – Operating Systems
Department of Mathematics and Computer Science
Spring 2019

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e-mail sanjiv@umsl.edu
urls http://www.cs.umsl.edu/~sanjiv
http://www.cs.umsl.edu/~sanjiv/classes/cs4760
Office Hrs MW 06:45pm – 08:15pm
Any other time by appointment
Prerequisites Cmp Sc 2700, Cmp Sc 2750, and Cmp Sc 3130

Course Description Covers the structure of a generic operating system, considering in detail the algorithms for interprocess communications, process scheduling, resource management, memory management, file systems, and device management. Presents examples from contemporary operating systems. This course also requires practical projects implemented within a modern operating system or simulator environment.

Required texts:


Topics We’ll discuss the structure of a generic operating system, with an emphasis on the algorithms and data structures needed to perform various tasks to manage processes, resources, memory, files, and I/O devices. There will be extensive programming in C under Linux environment. The sequence of topics will be as follows (in that order):

- Concurrent Programming, Process Interaction and Synchronization.
- Process Management and Scheduling.
- Resource Management and Deadlock Problem.
- Memory Management.
- File System and I/O management.

Outcomes At the end of this course, you are expected to be able to proficiently perform system programming tasks. You should also be knowledgeable in different operating systems topics as outlined above. You should understand the algorithms to achieve various tasks in operating systems and use the knowledge to improve the performance of your programs.

Requirements I’ll expect you to be present in most of the classes. I will not be taking attendance but if you start missing too many classes, please take responsibility for your absence, specially when it concerns tests and
homeworks. When you come to class, you must change your cell phones to silent mode. If your cell phone rings during the test, I'll deduct 10% points from that test score for you. If you are more than ten minutes late, please try to not disrupt the class. I'll penalize you by one letter grade for habitually coming late to class (more than five times I notice you coming late).

All correspondence should be made through your UMSL-provided email. Please use the class email list on Canvas for communications. Any unsigned email and email not in plain text will go unanswered by me. Please do not send me any attachments without talking to me first.

Projects: You will be given programming assignments, typically a set of programs every two weeks. Assignments will be due at 11:59pm on the day noted on the assignment. Assignments should be submitted on hoare and must execute properly on hoare for credit. You should start working on the projects as soon as they get assigned as some of them may get tricky. In the past, the students who have asked a lot of questions have scored better grades. Do not hesitate to ask a question in class, in my office, or over email, especially if you do not have an idea on how to start working on the project.

Grading The grade will be based on programming assignments and three tests. All tests will be open book and open notes. Each assignment must be meticulously documented and clearly identify its purpose, author, and date. I will like to read your submitted code; I should not have to figure it out. It will do you good if you peruse the Gnu Coding Standards at http://www.gnu.org/prep/standards/. When you come to me for help with the code, or when you submit the code, make sure that you follow good indentation practices. If you miss any test or assignment without making prior arrangements, you will have a zero. When making such arrangements, please stop by my office instead of sending me an email. I will not give any make up tests. The distribution of grades will be as follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Programming Assignments</td>
<td>40%</td>
</tr>
<tr>
<td>Three Tests</td>
<td>20% each</td>
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</table>

Students taking the course in graduate standing will be required to show a greater mastery of the material. This can be shown by additional work and additional mastery shown in exams.

Anyone desiring an EXC grade after March 31, 2019 must be passing the course at that point to get EXC.

Failure to hand in any assignment will result in an automatic zero for that assignment. If some student is unable to hand in an assignment by the deadline, he/she must discuss it with me before the deadline. I’ll encourage you to talk to other students regarding homework but you should not collaborate to the extent that two submissions are copies of each other. If you are found copying an assignment (from another student or internet), or if your submission has unreasonable similarity to another submission, you get a zero for that assignment automatically. A second offense will be reported to the University officials and students involved will face serious consequences. I may ask you to come to my office and explain your code to me; in case you are not able to explain the code to my satisfaction, I’ll assign you a zero in that project.

Instructional Strategies The instruction will follow the standard lectures using PDF notes as an aid. You are encouraged to ask questions if something is not clear or if you start to get lost in the lectures. If a project is not clear to you, you should ask questions to clarify that in class, in my office, or via email. If you do not have any idea on how to start working on a project, say so and I’ll try my best to help you. However, I’ll expect that you will ask project-related questions early on and not at the last minute when the project is due.

Miscellaneous If you have any disability that requires an accommodation (as per UMSL policy), you must notify me in advance. If you cannot attend the class due to a religious holiday or a university-sanctioned event, please let me know in advance as well. For religious holiday, please also fill in the form available on the class web site. In case you are down with the flu, please stay absent from the class till you recover, and contact me via phone or email. I’ll try my best to make accommodation for you in that case.
You will have an account on the Linux machine \texttt{hoare.cs.umsl.edu} in the CS department and you should use it for all assignments. All programs must be done in C. Any assignment that fails to run on \texttt{hoare} automatically gets a zero. You can access \texttt{hoare} from home by signing on to campus \texttt{VPN}, or by logging on to \texttt{delmar} and then, ssh’ing from there. The lecture notes and old tests are available on the class web page in PDF format. You may want to print the lecture notes before you come to class.

\textbf{Exam Dates}

<table>
<thead>
<tr>
<th>Test</th>
<th>Date</th>
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<tbody>
<tr>
<td>1</td>
<td>Feb 20, 2019</td>
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<tr>
<td>2</td>
<td>Mar 20, 2019</td>
</tr>
<tr>
<td>3</td>
<td>May 13, 2019; 07:45pm</td>
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</table>

In case of class cancellation due to weather-related or other campus emergency on the day of a test, the test will be held in the following class period. For the third test, if the campus is closed on the scheduled date, the alternative date will be the day after the scheduled date; possibly in the conference room of the department.

\textbf{Other Important Dates}

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>Jan 28, 2019</td>
<td>Last day to enroll in the course</td>
</tr>
<tr>
<td>Feb 18, 2019</td>
<td>Last day to drop without receiving a grade</td>
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<tr>
<td>Mar 18, 2019</td>
<td>Last day to drop the course without instructor approval</td>
</tr>
<tr>
<td>Apr 22, 2019</td>
<td>Last day to drop the course with instructor approval</td>
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</tbody>
</table>

Anyone desiring an EXC grade after March 31, 2019 must be passing the course at that point to get EXC.

\textbf{UMSL Course Policies}

1. Participation (expectations)

   - It is vitally important that our classroom environment promote the respectful exchange of ideas. This entails being sensitive to the views and beliefs expressed during discussions whether in class or online. Please speak with me before recording any class activity. It is a violation of University of Missouri policy to distribute such recordings without my authorization and the permission of others who are recorded.

   - Your success in this course will heavily depend on your ability to communicate, engage and participate in all course activities. Successful completion of this course requires that a student keep up with all assignments, quizzes, projects and tests.

   - Turn off sound on beepers, cell phones, and other devices during class. Adherence to the Student Conduct Code is expected.

   - I am committed to insuring a positive learning environment by respecting that University policy (p. 66): \url{http://www.umsl.edu/~studentplanner/index.html}.

   - If you are unable to participate in the scheduled class activities, you must notify the instructor within the week of that class module. An unexcused failure to engage or participate with the class will be counted as an absence; unexcused absences may result in failure. The instructor reserves the right to make judgment to accept and/or makeup assignments missed because of failed participation in the course activities.

2. Academic Integrity/Plagiarism
• Students are responsible for being attentive to and observant of campus policies about academic honesty as stated in the University’s Student Conduct Code (p. 60): http://www.umsl.edu/~studentplanner/index.html

• To avoid accusations of academic dishonesty, please submit all written work to the Turnitin system before finalizing what you submit for evaluation. Check information about The Writing Center @UMSL that is linked to MyGateway Home.

• Plagiarism is the use of another person’s words or ideas without crediting that person. Plagiarism and cheating will not be tolerated and may lead to failure on an assignment, in the class, and dismissal from the University. View this campus policy here: http://www.umsl.edu/services/academic/policy/academic-dishonesty.html

3. Mandatory Reporting: Under Title IX, all UMSL faculty, staff, and administrators (with limited exception) are obligated to report any incidents of sexual harassment, sexual misconduct, sexual assault, or gender discrimination to the Student Affairs office and/or other University officials. This ensures that all parties are protected from further abuses and that victim(s) are supported by trained counselors and professionals. Note: There are several offices at UMSL (e.g., Counseling Services, Health Services, Community Psychological Service, Center for Trauma Recovery, and Student Social Services) whose staff are exempt from Title IX mandated reporting, when the information is learned in the course of a confidential communication.

4. Access, Disability and Communication

• Students who have a health condition or disability, which may require accommodations in order to participate effectively in this course, should contact the Disability Access Services Office. Information about your disability is confidential.
  – 144 Millennium Student Center
  – Phone: (314) 516-6554
  – Website: http://www.umsl.edu/services/disability/

• If you have difficulty communicating in English with the instructor of this course, contact the Office of International Students and Scholar Services:
  – Phone: (314) 516-5229
  – Email: iss@umsl.edu
  – Website: http://www.umsl.edu/~intelstu/index.html

Student Support and Services

• Technical Support
  – My Gateway (Blackboard): If you have problems logging into your online course, or an issue within the course site, please contact the Technology Support Center:
    * Phone: (314) 516-6034
    * Email: helpdesk@umsl.edu
    * Website: http://www.umsl.edu/technology/tsc/

• Academic Support
  – The Online Writing Lab: At our My Gateway site, students can send their papers to our tutors, who will read them and send them back with suggestions. Students can also access SafeAssign, which identifies quoted material in their essays.
∗ Visit the online Writing Lab page on MyGateway to submit drafts online.
∗ We try to respond within 48 hours, but it may take longer, so allow ample time.

– **NetTutor**: Online tutoring in many subjects is now available through NetTutor®. In your courses on MyGateway, click on Tools and select NetTutor® to log in.

• **Student Services**

  – The Student Retention Services office offers assistance tailored to specific student needs.
    ∗ 225 Millennium Student Center
    ∗ Phone: (314) 516-5300
    ∗ Email: umslsrs@umsl.edu
    ∗ Website: http://www.umsl.edu/services/srs/

• **Departmental Tutoring**

  – The department offers tutoring for up to Cmp Sci 3130, and occasionally for other courses
  – Check MyGateway organization CSTutoring.

**Tentative Calendar**

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Overview of operating systems and concepts</th>
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<tbody>
<tr>
<td>Week 2</td>
<td>Overview of operating systems and concepts; Interprocess Communications</td>
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<tr>
<td>Week 3</td>
<td>Interprocess Communications</td>
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<tr>
<td>Week 4</td>
<td>Interprocess Communications</td>
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<tr>
<td>Week 5</td>
<td>Interprocess Communications; Test 1</td>
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<tr>
<td>Week 6</td>
<td>Process Management</td>
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<td>Week 7</td>
<td>Process Management</td>
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<td>Week 8</td>
<td>Process Management</td>
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<tr>
<td>Week 9</td>
<td>Resource Management; Test 2</td>
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<td>Week 10</td>
<td>Spring Break</td>
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<tr>
<td>Week 11</td>
<td>Resource Management</td>
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<tr>
<td>Week 12</td>
<td>Memory Management</td>
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<td>Week 13</td>
<td>Memory Management</td>
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<tr>
<td>Week 14</td>
<td>File Systems</td>
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<tr>
<td>Week 15</td>
<td>File Systems; I/O Management</td>
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<tr>
<td>Week 16</td>
<td>I/O Management; Test 3</td>
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Detailed course outline

1. Introduction
   - Basic elements of a computer system: processor, memory, I/O modules
   - Evolution of a microprocessor
   - Instruction execution
   - Interrupts
   - Processor registers
   - Memory hierarchy
   - Multiprocessor and multicore organization
   - Classification of operating systems
   - Process execution modes in Unix/Linux
   - Overview of operating systems structuring methods like monolithic, layered, and object-oriented
   - I/O communication
   - Multiprogramming and multitasking

2. Process Coordination and Synchronization
   - Process concept
   - Overview of multitasking and role of interrupts
   - Concurrent execution and precedence graphs (process flow diagrams)
   - Race conditions, Sharing access
   - Critical Section Problem
     - Models for two processes, including Dekker’s Algorithm
     - Models for multiple processes, including Bakery Algorithm
     - Semaphores, mutex locks, and monitors

3. Process Scheduling and Dispatch
   - Preemptive and non-preemptive scheduling strategies
   - Short term, medium-term, and long-term scheduling

4. Deadlocks – Causes, conditions, avoidance, prevention, and resolution

5. Physical and Virtual Memory Organization
   - Offset registers, partitions, pages, segments, swapping, overlays
   - Caching and associative buffers
   - Fetch, placement, and replacement policies
   - Thrashing and working sets

6. Device and File Management
   - File systems
• File types
• File access and directory management
• Distributed file systems
• Equivalence of files and devices
• Organization of I/O subsystems, free space management, and file layout
• Disk scheduling algorithms