COSC594/690
Advanced Operating Systems: Implementation & Design

SYLLABUS

Spring 2019 Course Description

Writing an original operating system using state-of-the-art techniques and design implementations.

Contact Hour Distribution: 3 hours.
Credit Restriction: Graduate.
Required Skills: Programming proficiency in C or C++.
Recommended Background: COSC360 (Systems Programming), ECE 555 or 451.
Recommended Skills: Knowledge of ARM or RISC-V assembly.
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I. General Information

1.1. Purpose. This syllabus describes the COSC594/690 course, policies, and procedures. This syllabus is mandatory for all students enrolled in COSC594/690.

1.2. Scope. This syllabus applies to all students enrolled in the COSC594/690 course at the Min H. Kao Department of Electrical Engineering and Computer Science (http://www.eecs.utk.edu) of the Tickle College of Engineering (http://tickle.utk.edu) of the University of Tennessee (http://www.utk.edu).

1.3. Amendments. Amendments may be made to this syllabus with or without notification; therefore, do NOT save this syllabus. Instead, retrieve it from Canvas every time in case it happens to update. Use the date at the lower-right corner of the syllabus to determine if you’re reading the most up-to-date version. A summary of changes will be provided on the syllabus.

1.4. Current Version. The most current version of this syllabus may be downloaded at: http://tiny.utk.edu/advos.

1.5. Key Words.
   1.5.1. "Will", "must", and "shall" indicate a mandatory requirement.
   1.5.2. "Should" is used to indicate a preferred, but not mandatory, method.
   1.5.3. "May" indicates an acceptable or suggested means.
   1.5.4. “UTK” is short for the “University of Tennessee at Knoxville”.
   1.5.5. “TBD” is short for “To Be Determined”.
   1.5.6. “IAW” is short for “In Accordance With”.

1.6. Learning Management System. All students will be required to use Canvas as the learning management system. COSC594/690 for the Spring 2019 semester is at: https://tiny.utk.edu/canvas_advos.

1.6.1. Calendar. The Canvas calendar will be used to notify any class cancellations for any purpose, including holidays. Students will be required to frequently check their Canvas calendar for due dates and class dates.

1.7. Times and Dates. All times and dates, including due dates, will use the Eastern Time Zone and will observe spring and fall time changes (EST and EDT). Furthermore, all times will use a 24-hour clock (e.g., 1100 = 11:00am, 1200 = 12:00pm, 1500 = 3:00pm, 1800 = 6:00pm, 2200 = 10:00pm, etc.).

1.8. Student Information and Accommodations. All student information will be kept confidential in accordance with the Family Educational Rights and Privacy Act of 1974 (FERPA). More information may be found at: https://ferpa.utk.edu.
1.8.1. **FERPA Waiver.** Students may waive some or all their FERPA rights, typically in cases such as letters of recommendations. Students must complete and sign a FERPA form before any FERPA-related information is released.

1.8.2. **Disclosure.** All student information is covered under FERPA and will not be disclosed to anyone, including students' parents. FERPA information necessary for this course is retrievable by the professors, undergraduate teaching assistants, and graduate teaching assistants.

1.8.3. **Disability.** Any students who have disabilities may register with the Office of Student Disability Services (SDS) for a range of accommodations. No accommodations will be made without prior approval from SDS.

1.8.3.1. **SDS Website.** More information about SDS may be found at: [https://sds.utk.edu](https://sds.utk.edu).

1.9. **Deviations.**

1.9.1. While compliance with this syllabus is mandatory, the following exceptions to policy may be made given:

1.9.1.1. All exception to policy rules must be in writing (unless otherwise noted), or

1.9.1.2. Exceptions to policy rules must be made at the department head level, or

1.9.1.3. Any illness, injury, death in the family, and so forth requires an "absence request" from the Dean of Students ([https://dos.utk.edu](https://dos.utk.edu)).

1.9.2. For unusual circumstances, the professor or instructor may deviate from this syllabus on a case-by-case basis.

1.9.2.1. TAs and other representatives of this course may suggest deviations, but they are not permitted to approve deviations and must comply with 1.9.1 above.

1.10. **Teaching Assistants (TA).** Teaching assistants are representatives of the COSC594/690 professors. They have full access to all student information, including grades. Teaching assistants may be undergraduate (UTA) or graduate students (GTA), or both.

1.10.1. **Enrollment/Availability.** If enrollment is not high enough, TAs (UTA or GTA) will not be assigned to this course.

1.11. **Supplemental Instructors (SI).** Supplemental instruction is not available for this course.

1.12. **Contacts.** Electronic communications will be made to the professor and teaching assistants through Piazza. A link is provided on Canvas to connect to Piazza.

1.12.1. **Email Correspondence.** For most purposes, do NOT email a teaching assistant of professor directly. These emails are likely to be ignored.

1.13. **Letters of Recommendations.** Letters of recommendations may be written for COSC594/690 students. Exceptions to this policy may be made by the professor on a case-by-case basis.
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1.13.1. FERPA Requirements. Any letter of recommendation written must have a signed FERPA waiver on file with the professor writing the letter. The form may be downloaded from http://tiny.utk.edu/marz_ferpa.
II. Office Hours

1.1. Office Hours. The professor will hold regular office hours. All information regarding office hours, including times and locations, will be posted to Canvas.
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III. Course Work

1.1. Textbooks. No textbook has been assigned to this course.


1.2. Assignments. Students will be assigned and graded based on a variety of assignments. Students have the option to join a group, and students are highly encouraged to join a group.

1.2.1. Anticipated Workload (NO GROUP). COSC594: 10 hrs/wk, COSC690: 14 hrs/wk. This workload is based on a student NOT participating in a group.

1.2.2. Anticipated Workload (GROUP). COSC594: 4 hrs/wk, COSC690: 6 hrs/wk. This workload is based on a student participating in a group of 3 or more.

1.2.3. Submissions. All assignments will be submitted to Canvas. Submissions sent via Piazza or email to a professor or teaching assistant will be ignored.

1.2.4. Homework. Students will complete homework assigned using Canvas. These will be Canvas quizzes and in the format of multiple choice or fill-in-the-blank questions. Expect about 5 questions per week.

1.2.5. Labs. Group labs will be assigned. Only one (1) group member will submit the lab through Canvas (see Figure 1).

1.2.5.1. Comments. Students may make comments on their submission; however, these have no bearing on the students’ grading. Graders are NOT given notification when a student makes a comment. Therefore, students will not make comments after the assignment has been graded.

1.2.5.1.2. Recency. Only your latest submission will be graded. If you previously submitted your lab prior to the due date and subsequently submitted past the due date, the lab submitted past the due date will be graded and subject to late penalties.
1.2.6. Exams. No exams will be given for this course.

1.3. Due Dates. All due dates will be listed on Canvas.

1.3.1. Diligence. Students are responsible to check Canvas regularly for any due dates.

1.4. Late Policy. Students may submit assignments up to three (3) days late.

1.4.1. Penalty. Late assignments will be penalized 5% per hour it is submitted past the due date. The penalty is automatically applied by Canvas.

1.5. Grading.

1.5.1. Weights. The weight of each grading category is listed on Canvas under “Syllabus”.

1.5.2. Canvas. Students must make sure that the checkbox shown in Figure 2 is unchecked. Otherwise, assignments not submitted will not count against the student’s grade.

1.5.3. Homework. Homework is automatically graded using Canvas.

1.5.4. Labs. Teaching assistants or the professor will typically grade lab submissions.

1.5.4.1. Comments and Formatting. All student lab submissions must be properly formatted and commented, including a commented header which includes the students’ names, date, and a summary of the lab.

1.5.5. Lab Reviews. Students will review each other’s group labs as part of an assignment. Lab reviews will be completed using Canvas.

1.5.6. Appeals. Students may appeal the grade they received. Students must send a Piazza message to all "Instructors" with the assignment whose grade they wish to appeal.
1.5.6.1. Timeliness. Appeals must be made within ten (10) days of receiving the grade.

1.6. Grade Curving. Grades will not be curved or rounded. Grades will not be "bumped" to another grade level no matter how close it is.

1.7. Extra Credit. Several opportunities may be given to earn extra credit.

1.7.1. End of Course Survey. An end of course survey will be offered. This course survey will permit a student to earn extra points towards their final grade. This is used in lieu of curving and rounding grades.

1.7.1.1. Survey Credit. The amount of extra credit given for the end of course survey will be indicated on Canvas.

1.8. Official University Appeal. A student may appeal their final grade with the University of Tennessee. The procedures for doing so are outlined at:
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IV. Code of Conduct

1.1. **Honor Statement.** Students will conduct themselves according to the University of Tennessee Hilltopics Honor Statement, which may be viewed at: [http://catalog.utk.edu/content.php?catoid=24&navoid=3078#hono_stat](http://catalog.utk.edu/content.php?catoid=24&navoid=3078#hono_stat).

1.2. **Behavior.** Any student who exhibits inappropriate behavior may be admonished immediately and/or referred to student conduct (see section 1.3.4.3 below). Continued inappropriate behavior may involve the University of Tennessee Police Department (UTPD).

1.3. **Plagiarism and Cheating.** Any student who is suspected of plagiarism and/or cheating will receive a penalty for doing so. The student will not be notified in advance at the penalty or that they were suspected of violating the plagiarism and/or cheating policy. Instead, it is the student’s responsibility for contacting their professor.

1.3.1. **Group Work.** Group work will only be considered plagiarism/cheating if it matches another group, not within the group.

1.3.2. **Examples of Cheating.** Plagiarism and cheating may result from a student copying an assignment or sections of an assignment from another student, from an online source, or from the student’s own previous assignment (from a previous attempt at the course).

1.3.3. **Working Together.** Students are encouraged to work together, however this increases the risk of plagiarism and/or cheating. Students are cautioned to make sure that when they work together that their code cannot be seen by another student. We recommend that students work together by placing their laptops back to back. With this method, students may discuss topics, but the code they write is purely their own.

1.3.3.1. **Citation.** Always cite any professor, teaching assistant, or another student with whom you discussed the work with. Even if you cannot see another student’s code, the chances of parallel thinking are increased. When you cite whom you worked with, we can understand where your lab may look like another.

1.3.3.1.1. **Parallel Thinking.** Citations do NOT preclude you from abiding by the plagiarism/cheating policy. Even if you cite your source, you may still not copy code in portions or entirety.

1.3.4. **Penalties.** The professors and teaching assistants are not investigation units. Therefore, anyone found in violation of the plagiarism policy will receive the same penalty regardless of who originated the content.

1.3.4.1. **Labs/Homework.** Students will receive a 0 for the lab or homework and a ten (10) point drop on their final grade. This will appear as a “Plagiarism” column on Canvas. Essentially, it removes exam points to achieve a 10-point drop on the student’s final grade.
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1.3.4.1. Repeated Violations. Repeated violations of the plagiarism or cheating policy will result in a 0 for the course.

1.3.4.2. Stolen Work. If an allegation of theft is made, the theft will immediately be reported to student conduct for an investigation.

1.3.4.3. Referrals. The professors and teaching assistants reserve the right to refer any student behavior to student conduct regardless of previous incidents, or lack thereof. More information about referrals and student conduct may be found at: https://studentconduct.utk.edu.
V. Transcript Grades

1.1. Letter Grades. Numeric grades will follow Table 1 to translate to the final letter grade.

<table>
<thead>
<tr>
<th>Letter</th>
<th>Floor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>90</td>
</tr>
<tr>
<td>B</td>
<td>80</td>
</tr>
<tr>
<td>C</td>
<td>70</td>
</tr>
<tr>
<td>D</td>
<td>60</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
</tr>
</tbody>
</table>

*Table 1: Letter Grade Conversion*
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VI. Schedule

1.1. Dates. All key dates and times will be listed on the course's calendar on Canvas.

1.2. Attendance. Attending all lectures is mandatory.

1.3. Lecture. Lectures will be held on Mondays, Wednesdays, and Fridays in Min Kao Room 406 and start at 1325 and end at 1415.

   1.3.1. Instructor. A teaching assistant or another professor may substitute for a class, or a class may be canceled if the primary instructor is unable to teach for any reason, such as due to an illness.

   1.3.2. Expectation. You will be required to write code and work with your group during class
VII. Weekly Topics

1.1. Spring 2019. The weekly course schedule, Table 2, describes the topics that will be covered during the spring 2019 semester.

1.1.1. Date. The date refers to the first day of the week that the topics will be covered.

1.2. Changes. Changes to the schedule may be made with or without notice.

<table>
<thead>
<tr>
<th>Week</th>
<th>Begins</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>01/09</td>
<td>Introduction, set-up, Rust</td>
</tr>
<tr>
<td>02</td>
<td>01/14</td>
<td>Rust programming</td>
</tr>
<tr>
<td>03</td>
<td>01/21</td>
<td>RISC-V assembly</td>
</tr>
<tr>
<td>04</td>
<td>01/28</td>
<td>Xargo, build tools, linker scripts</td>
</tr>
<tr>
<td>05</td>
<td>02/04</td>
<td>Booting, RISC-V Qemu; E31(690), HF1(594)</td>
</tr>
<tr>
<td>06</td>
<td>02/11</td>
<td>UART, console, macros</td>
</tr>
<tr>
<td>07</td>
<td>02/18</td>
<td>Locking, timers, interrupts</td>
</tr>
<tr>
<td>08</td>
<td>02/25</td>
<td>Memory, memory management; PMP (690)</td>
</tr>
<tr>
<td>09</td>
<td>03/04</td>
<td>Environment (system) calls</td>
</tr>
<tr>
<td>10</td>
<td>03/11</td>
<td>Tasks, IPC; user mode (690)</td>
</tr>
<tr>
<td>11</td>
<td>03/18</td>
<td>Spring break (NO CLASS)</td>
</tr>
<tr>
<td>12</td>
<td>03/25</td>
<td>Scheduling, context switching; CFS (690)</td>
</tr>
<tr>
<td>13</td>
<td>04/01</td>
<td>Mass storage (690)</td>
</tr>
<tr>
<td>14</td>
<td>04/08</td>
<td>Filesystems; Ext2 (690)</td>
</tr>
<tr>
<td>15</td>
<td>04/15</td>
<td>Filesystems</td>
</tr>
<tr>
<td>16</td>
<td>04/22</td>
<td>ELF (690)</td>
</tr>
</tbody>
</table>

*Table 2: Weekly Topics*
VIII. Learning Objectives

After completing this course, a successful student should be able to perform/accomplish the following.

**Booting**

1. Write assembly code to transfer control to the operating system.
2. Write assembly code to control which CPUs (in a multi-CPU system) are operating.

**Interrupts**

1. Understand how to control interrupts and how to vector interrupts to certain kernel functions.
2. Understand how software interrupts and system calls are performed.

**Drivers**

1. Develop a driver to control hardware to interact with the user (input and output).
2. Develop kernel code to control input and output efficiently.

**Task Scheduling**

1. Develop an efficient scheduler which controls kernel and user tasks.
2. Be able to context switch among several tasks (processes).
3. (COSC690) Be able to context switch to user space from kernel space and vice-versa.

**File Systems**

1. Develop a file system capable of reading, writing, and storing meta-data of files.
2. (COSC690) Use hardware to read/write files to a block device.

**Memory Management**

1. Program the kernel to allocate memory for tasks.
2. Segment memory to avoid conflicts.
3. (COSC690) Program the memory management unit to allocate user-space tasks available memory.
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IX. Summary of Changes
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X. Approval

Dr. Stephen Marz
Lecturer