EEL 4732/5733 Advanced Systems Programming

1. Catalog Description – (3 credits) Develop a deep understanding of operating system concepts and systems programming fundamentals and gain hands-on experience in systems programming by using Pthreads as well as implementing Linux device drivers and testing/verifying systems code for deadlock and race-freedom.
2. Pre-requisites:

   - C programming knowledge
   - COP 4600 (or equivalent) or EEL 5737 (for EEL 5733)
   - EEL 3701C (or equivalent), EEL 3834 (or equivalent), and COP 4600 (or equivalent) (for EEL 4732)

3. Course Objectives – To learn the architecture and inner-workings of a real-world operating system and to learn how to write, test, and debug multi-threaded applications and device drivers in the face of a complicated concurrency model.
4. Contribution of course to meeting the professional component (ABET only – undergraduate courses) 3 credits of Engineering Science (for EEL 4930).
5. Relationship of course to program outcomes: Skills student will develop in this course (ABET only undergraduate courses) Outcomes a and k (for EEL 4930).
6. Instructor –Dr. Tuba Yavuz
   1. Office location: 321 Benton Hall
   2. Telephone: 352-8460202
   3. E-mail address: tuba@ece.ufl.edu
   4. Class Web site: E-learning CANVAS.
   5. Office hours: Mondays 1pm – 2pm & Thursdays 2pm – 3pm.
7. Teaching Assistant – Farhaan Fowze
   1. Office location: 320 Larsen Hall
   2. Telephone:
   3. E-mail address: farhaan104@ufl.edu
   4. Office hours: Tuesdays 1:30 pm – 3:30 pm, Thursdays 2:30 pm – 3:30 pm.
8. Teaching Assistant – Ken (Yihang) Bai
   1. Office location: 320 Larsen Hall
   2. Telephone:
   3. E-mail address: baiyihang@ufl.edu
   4. Office hours: Wednesdays 2 pm – 4 pm, Fridays 2 pm – 4 pm.
9. Meeting times: MWF 3rd period.
10. Class/laboratory schedule - 3 class periods consisting of 50 minutes each
11. Meeting Location – NEB 201.
12. Material and Supply Fees - None
13. Textbooks and Software Required – None.
14. Recommended Reading –

    1. Title: Linux System Programming
    2. Author: Robert Love

3. Publication date and edition: 2013, 2nd
4. ISBN number: 978-1-449-33953-1

1. Title: The Linux Programming Interface
2. Author: Michael Kerrisk
3. Publication date and edition: 2010, 1st
4. ISBN number: 978-1593272203

1. Title: Linux Device Drivers
2. Author: Corbet, Rubini, & Kroah-Hartman
3. Publication date and edition: 2005, 3rd
4. ISBN number: 978-0-596-00590-0

15. Course Outline –

Week 1: Introduction to Operating Systems Concepts/Yavuz/Ch.1 of Linux System Programming

Week 2: Inter-process communication mechanisms/Yavuz/Ch.s 7 and 10 of Linux System Programming

Week 3: Pthreads Library/Yavuz/Tutorial at https://computing.llnl.gov/tutorials/pthreads/

Week 4: Solving classical IPC problems using Pthreads/Yavuz/ Tutorial at https://computing.llnl.gov/tutorials/pthreads/

Week 5: Virtual Memory Management/Yavuz/Online document at http://www.tldp.org/LDP/tlk/mm/memory.html

Week 6: Mapping Memory/Yavuz/Ch.9 of Linux System Programming

Week 7: File System Management/Yavuz/Ch 4. of Linux System Programming and http://www.tldp.org/LDP/tlk/fs/filesystem.html

Week 8: Introduction to Device Drivers/Yavuz/Ch.s 1 and 2 of Linux Device Drivers

Week 9: Char Drivers/Yavuz/Ch. 3 of Linux Device Drivers/Exam 1

Week 10: Memory Mapping and DMA/Yavuz/Ch. 15 of Linux Device Drivers

Week 11: I/O Mechanisms/Yavuz/Ch.s 9 and 10 of Linux Device Drivers

Week 12: Concurrency and Race Conditions/Yavuz/Ch. 5 of Linux Device Drivers

Week 13: USB Device Drivers/Yavuz/Ch. 13 of Linux Device Drivers

Week 14: Testing a USB Keyboard Driver & Typical Device Driver Bugs/Yavuz/Representative bugs detected by Linux Driver Verification project http://linuxtesting.org/project/ldv

Week 15: USB Block Drivers/Yavuz/Ch. 16 of Linux Device Drivers

Week 16: Analyzing Device Drivers for Deadlocks and Race Conditions and Other Bugs & Wrap-up & Review/Yavuz/ Thorough Static Analysis of Device Drivers, Thomas Ball, Ella Bounimova, Vladimir Levin, Jakob Lichtenberg, Con McGarvey, Bohus Ondrusek, Sriram Rajamani, Byron Cook, Abdullah Ustuner, in EuroSys 2006, April 1, 2006.

16. Attendance and Expectations - Attendance is expected. Cell phones and other electronic devices are to be silenced. No text messaging during class or exams.

    Requirements for class attendance and make-up exams, assignments, and other work are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

17. Grading –

    Participation (5%): Students are expected to participate by asking and answering questions during lectures. Students will be expected to keep a log on CANVAS and will be responsible for recording the details (wording of the question/answer along with the date). There may be several graded in-class group activities throughout the semester. Students can leverage these activities towards participation as well.

    Important Note: Questions will be evaluated based on their relevance to the topic and the answers will be evaluated based on the correctness. In-class group activities will not be announced before hand. Therefore, regular attendance is highly recommended. EDGE students will be provided with a description of the activity and a deadline to submit their answers.

    Programming Assignments (30%):

Assignment1: Advanced User-Space Programming
Assignment2: Pthreads
Assignment3: File Systems
Assignment4: A simple char device driver
Assignment5: A thread-safe char device driver
Assignment6: Testing the USB keyboard driver

Exams (65%): There will be 2 closed books and notes exams.
Midterm Exam (30%): Wednesday, February 26th (regular class time and place)

Final Exam (35%): Tuesday, April 28th (7:30 am – 9:30 am, NEB 201)

Note: This course is co-listed with the graduate class. The homework portion of the graduate section will involve additional work and more advanced concepts with respect to the undergraduate section. The exams will also involve more advanced concepts with respect to the undergraduate section.

18. Grading Scale –

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
93-100	90-92	87-89	83-86	80-82	77-79	73-76	70-72	67-69	63-66	60-62	0-59

In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better)." Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement. For more information on grades and grading policies, please visit:
http://gradschool.ufl.edu/catalog/current-catalog/catalog-general-regulations.html#grades

19. Make-Up Exam Policy - If you have a University-approved excuse and arrange for it in advance, or in case of documented emergency, a make-up exam will be allowed and arrangements can be made for making up missed work. University attendance policies can be found at:
https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Otherwise, make-up exams will be considered only in extraordinary cases, and must be taken before the scheduled exam. The student must submit a written petition to the instructor two weeks prior to the scheduled exam and the instructor must approve the petition.

19. Honesty Policy – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

    "...failure to comply with this commitment will result in disciplinary action compliant with the UF Student Honor Code Procedures (http://www.dso.ufl.edu/sccr/procedures/honorcode.php)

20. Accommodation for Students with Disabilities – Students Requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

21. UF Counseling Services – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
    - · UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
    - · Career Resource Center, Reitz Union, 392-1601, career and job search services.

22. Software Use – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

23. Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://evaluations.ufl.edu. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://evaluations.ufl.edu/results/.