CS 4530 / 7530, Cloud Computing

Instructor: Dr. Prasad Calyam (calyamp@missouri.edu)

Lectures: Two 75-minute lecture sessions and one 2-hour lab/homework every week

Course Description: This course covers principles that integrate computing theories and information technologies with the design, programming and application of distributed systems. The course topics will familiarize students with distributed system models and enabling technologies; virtual machines and virtualization of clusters, networks and data centers; cloud platform architecture with security over virtualized data centers; service-oriented architectures for distributed computing; and cloud programming and software environments. Additionally, students will learn how to conduct some parallel and distributed programming and performance evaluation experiments on applications within available cloud platforms. Finally we will survey research literature and latest technology trends that are shaping the future of high performance, distributed and cloud computing. Graduate students enrolled in the course will have a collaborative programming project using tools and software environments available within real cloud platforms.

Prerequisite: CS 3330 or Instructor Consent


Course Topics: This course will explore the principles that integrate computing theories and information technologies with the design, programming, security and application of distributed systems. Topics include:

- Distributed system models and enabling technologies
  - Scalable, utility computing evolution and concepts
  - Networked systems related technologies
  - Performance, security, and energy efficiency issues
- Virtual machines and virtualization of clusters, networks and data centers
  - Levels of virtualization implementation
  - Structures/tools and mechanisms for resource management
- Cloud platform architecture with security over virtualized data centers
  - Public, private and hybrid clouds ecosystem
  - Public clouds and service offerings such as IaaS, PaaS, SaaS, DaaS
  - Inter-cloud resource management including Cloud-Fog management
  - Cloud security and trust management
- Service-oriented architectures for distributed computing
  - Web services and message-oriented middleware
  - Discovery, registries, metadata, publish-subscribe
- Cloud programming and software environments
  - Cloud application requirements and constraints
  - MapReduce, Hadoop library, Pig Latin, Storm, Spark
  - Programming support, approaches on real cloud platforms
**Homeworks, Labs and Projects:** There will be 4 Homeworks, 6 Labs and 1 Project (Project is optional for undergraduate students) assigned during the course. Homework assignments will be assigned to deepen understanding of concepts and will require students to read a major portion of the textbook chapters 1, 3, 4, 5 and 6. As part of each assignment, students will need to submit answers for select questions at the end of each chapter in the textbook. Students will perform homeworks *individually*. The solutions to all homework assignments will be discussed in class.

Lab exercises will be assigned to develop students’ skills and understanding for working with distributed system and related software environments. There will be 3 lab sessions that will focus on Amazon Web Services (AWS - [http://aws.amazon.com](http://aws.amazon.com)) and 3 other lab sessions that will focus on Global Environment for Network Innovations (GENI - [http://groups.geni.net/geni/wiki](http://groups.geni.net/geni/wiki)). Step-by-step instructions will be provided for each lab to access and use the public cloud resources, and a set of questions will need to be answered as part lab reports, which will demonstrate good understanding of the concepts being explored in the lab steps. Each student will receive a $100 AWS usage credit code; although each assigned lab session will only use free-tier resources, the credit can be helpful if there are accidental charges or if a student would like to experiment with any advanced AWS capabilities. **If a student exceeds the $100 usage credit, he/she will be responsible for payment of any overage charges.** You will be provided instructions in AWS Lab 1 to setup billing alerts to monitor usage, and **at the end of each AWS lab session, you should turn off your instances.**

To develop students’ programming and performance evaluation skills and to reinforce the understanding of major concepts discussed in the course, **Graduate/Undergraduate Student team projects will be assigned** that will require use of either C/C++ or Java, as well as cloud-platform specific tools and applications. Undergraduate Student participation is optional for the project assignment. However, Undergraduate Student participation in a project will change the grading points weightage of Lab Sessions and Final Exam that count towards the final grade. Each project team will be required to submit a written report with evaluation, demo video and an oral presentation in class.

**Grading:**

<table>
<thead>
<tr>
<th>ASSIGNMENTS</th>
<th>CS 4530 – Project</th>
<th>CS 4530 – No Project</th>
<th>CS 7530 – Project</th>
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<tbody>
<tr>
<td>Homeworks</td>
<td>20%</td>
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<td>20%</td>
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<tr>
<td>Lab Sessions</td>
<td>15%</td>
<td>30%</td>
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<tr>
<td>Midterm Exam</td>
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<tr>
<td>Final Exam</td>
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<tr>
<td>Project</td>
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<tr>
<td>Class Attendance</td>
<td>5%</td>
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Grading Scale:

Passing grades (A/B/C) ≥ 65%; +/- grades (A+, A-, B+, B-, C+, C-)

- **CS 4530 (Undergraduate):**
  - A+ (97-100), A (93-96), A- (89-92)
  - B+ (85-88), B (81-84), B- (77-80)
  - C+ (73-76), C (69-72), C- (65-68)
  - D+ (60-64), D (55-59)
  - F (< 55)

- **CS 7530 (Graduate):**
  - A+ (97-100), A (93-96), A- (89-92)
  - B+ (85-88), B (81-84), B- (77-80)
  - C+ (73-76), C (69-72), C- (65-68)
  - F (< 65)

**Team Work:** Teams for GENI labs and final project will be created in this course to develop team work and planning skills of students, as they are an important part of the engineering profession. Therefore, dividing the problem into parts and assigning parts to team members is not only proper, but advised. However, each member of the team is responsible for understanding all aspects about the GENI lab session and final project.

**Academic Dishonesty:** Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person’s work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The **academic community regards breaches of the academic integrity rules as extremely serious matters.** Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor. Any student found to have cheated during an exam will be given a 0 grade for that exam and the evidence will be sent to the Provost’s Office. Students submitting the same or similar solutions to homework or programming assignments will be given a 0 for the assignment and the evidence will be sent to the Provost's Office for determination of possible disciplinary action. Unless an assignment is specifically structured as a group project, duplicate homework written in collaboration with others is not acceptable. **Although it is permissible to discuss the homework with others, these discussions should be of a general nature. All work at a detailed level must be done on your own.** Students submitting the same or similar solutions to the homework will be considered as having cheated. No statements or actions made by anyone can alter this policy.

**ADA statement:** If you need accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class, or at my office. To request academic accommodations (for example,
a notetaker), students must also register with the Office of Disability Services, (http://disabilityservices.missouri.edu), S5 Memorial Union, 882-4696. It is the campus office responsible for reviewing documentation provided by students requesting academic accommodations, and for accommodations planning in cooperation with students and instructors, as needed and consistent with course requirements. For other MU resources for students with disabilities, click on “Disability Resources” on the MU homepage.

**Intellectual Pluralism:** The University community welcomes intellectual diversity and respects student rights. Students who have questions or concerns regarding the atmosphere in this class (including respect for diverse opinions) may contact the Departmental Chair or Divisional Director; the Director of the Office of Students Rights and Responsibilities (http://osrr.missouri.edu/) or the MU Equity Office (equity@missouri.edu; http://equity.missouri.edu/). All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.