WEST VIRGINIA UNIVERSITY

College of Engineering and Mineral Resources

Lane Department of Computer Science and Electrical Engineering

SENG 650 Cloud Computing and the Internet of Things

3 credit hours, Summer of even years

Class time: Once a week 6:00 pm – 8:20 pm **Location:** WVU eCampus, https://ecampus.wvu.edu/

Instructor: Prof. Hany Ammar

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Office hours: By appointment.

Prerequisites: SENG 550 or knowledge of Object-Oriented Programming and Design, and an undergraduate level knowledge of software engineering.

Course Materials: Course slides will be based on the following references

References:

1. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, by Kai Hwang, Geoffrey C. Fox, and Jack J. Dongarra, Publisher: Elsevier Inc., 2012. **Required Text**.
2. Cloud Computing for Machine Learning and Cognitive Applications, by Kai Hwang, MIT Press, (June 16, 2017).
3. Engineering Software as a Service: An Agile Approach Using Cloud Computing, by Armando Fox, David Patterson, Publisher: Strawberry Canyon LLC, 2014
4. Software Architecture for Big Data and the Cloud 1st Edition, by Ivan Mistrik (Editor), Rami Bahsoon (Editor), Nour Ali (Editor), Maritta Heisel (Editor), Bruce Maxim (Editor), Morgan Kaufmann; (June 26, 2017)
5. Microsoft Azure Essentials: Fundamentals of Azure. By Michael S. Collier and Robin E. Shahan, The "Microsoft Azure Essentials" series, https://mva.microsoft.com/ebooks#9780735697225
6. Cloud Design Patterns: Prescriptive Architecture Guidance for Cloud Applications https://msdn.microsoft.com/en-us/library/dn568099.aspx
7. Amazon Web Services: Architecting for the Cloud http://www.thepathtoagility.com/wp-content/uploads/2012/03/steveriley2.pdf
8. Cloud Application Modeling CAML https://code.google.com/archive/a/eclipselabs.org/p/caml

9. Cloud Computing: A Hands-On Approach, by Arshdeep Bahga, Vijay Madisetti, CreateSpace Independent Publishing Platform, 2013.
10. The Internet of Things, by Samuel Greengard, The MIT Press, 2015.
11. Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security, Perry Lea, Packt Publishing; 1 edition (January 22, 2018)
12. Microservices, IoT and Azure: Leveraging DevOps and Microservice Architecture to deliver SaaS Solutions, By B. Familiar, Apress; 1st ed. edition (October 20, 2015)
13. Learning the Internet of Things, by Peter Waher, Packt Publishing, 2015.
14. Building Internet of Things with the Arduino (Volume 1), by Charalampos Doukas, CreateSpace Independent Publishing Platform, 2012
15. Open Source Tools for the IoT: http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things-1.html
16. The dirty dozen: 12 cloud security threats, http://www.infoworld.com/article/3041078/security/the-dirty-dozen-12-cloud-security-threats.html
17. Google Cloud Platform Security, https://cloud.google.com/security/

Suggested Links for Project Ideas:

1. UML-based Cloud Application Modeling http://ceur-ws.org/Vol-1242/paper7.pdf
2. Cloud Application Modeling CAML https://code.google.com/archive/a/eclipselabs.org/p/caml
3. Managing multi-cloud systems with CloudMF http://dl.acm.org/citation.cfm?id=2513542
4. Cloud Computing Patterns http://www.cloudcomputingpatterns.org/ http://www.sei.cmu.edu/library/assets/presentations/retter-saturn2013.pdf
5. Cloud Design Patterns: Prescriptive Architecture Guidance for Cloud Applications https://msdn.microsoft.com/en-us/library/dn568099.aspx
6. Amazon Web Services: Architecting for the Cloud http://www.thepathtoagility.com/wp-content/uploads/2012/03/steveriley2.pdf
7. Ruby on Rails Tutorial Web development on the cloud, by Michael Hartl https://www.railstutorial.org/book/
8. Google App Engine https://cloud.google.com/appengine/docs
9. Microsoft Azure Essentials: Fundamentals of Azure, by Michael S. Collier and Robin E. Shahan,
10. Microservices with Azure: Build highly maintainable and scalable enterprise-grade appsJun 28, 2017, by Namit Tanasseri and Rahul Rai, Packt Publishing; 1 edition (June 28, 2017),
11. Open Source Tools for the IoT: http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things-1.html
12. ECLIPSE IOT: https://blog.benjamin-cabe.com/2015/12/21/eclipse-iots-2015-year-in-review

13. Open Source Tools and Resources for the IoT: http://techbeacon.com/67-open-source-tools-resources-iot
14. Intel IoT Developer Kit: https://software.intel.com/en-us/iot/hardware/devkit
15. Internet of Things with the Arduino Yún, by Marco Schwartz, Packt Publishing, 2014.

15. Make: Sensors: A Hands-On Primer for Monitoring the Real World with Arduino and Raspberry Pi, by Tero Karvinen, Kimmo Karvinen, Ville Valtokari, Maker Media, Inc., 2014.
16. Make: Wearable Electronics: Design, prototype, and wear your own interactive garments, by Kate Hartman
17. On the Integration of Cloud Computing and Internet of Things: Review the literature about the integration of Cloud and IoT. http://wpage.unina.it/walter.dedonato/pubs/iot_ficloud14.pdf

Method of instruction: Lecture. Offered online.

Course Description: This course investigates cloud computing and the Internet of Things (IoT) techniques, and architectures. Students will be exposed to the basic concepts and current practices of cloud computing. Topics include:

1. Distributed computing models and technologies,
2. Cloud Services: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS),
3. Virtualization, security and privacy issues,
4. Cloud Application Architectures and Programming Models,
5. The Internet of things architectures and patterns.
6. Example applications of IoT which is based several technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. Technologies such as RFID, short range wireless communications, real-time localization, and sensor networks are becoming increasingly pervasive, making the IoT a reality with applications in smart homes, smart cities, smart healthcare, and wearable devices.
7. Course work will include student presentations, and a term project that will provide exposure to scientific research in cloud computing and IoT.

Course Modules:

1. Introduction to Cloud Computing and IoT [1 week]
2. Virtual Machines and Virtualization of Clusters and Data Centers [1 week]
3. Cloud Platform Architecture [1 week]
4. Cloud Computing Applications Architecture Styles and Patterns [1 week]
5. Cloud Programming and Software Environments [2 week]
6. Security and Privacy issues in the Cloud [1 week]
7. Ubiquitous Clouds and the Internet of Things and their applications [2 weeks]
8. Project Presentations and Term Exam [2 weeks]

Course Learning Outcomes: Upon successful completion of SENG 650, students will be able to

1. Demonstrate knowledge of the basic concepts and technologies of Cloud Computing and IoT

2. Analyze and compare cloud computing architectures

3. Compare the Software Engineering Environments for developing cloud computing and IoT applications

4. Conduct studies on the use of cloud computing and IoT technologies in various application domains.

RULES OF OPERATION

Attendance: Students are expected to regularly follow the lectures. Students are responsible for all material covered in the course, keeping track of assignments' due dates and examination date. Students are required to attend the in-class discussions of assignments.

Communication: All course material, important announcements, assignments, etc. will be provided using the eCampus features. Please use the eCampus Course Messages feature or email to communicate with the Instructor and other students in the class. The instructor will make his best effort to respond within 24 hours.

Paper: will be required to submit project briefing presentations, final project presentation, and project final report using eCampus.

Exams: There will be a term exam which will cover class material and will be administered in the last week of classes.

Term project: Each student will conduct a multi-stage term project which will be based on the methods discussed in class. The project will have the following four stages: (1) Choosing a topic from the provided list and compiling the related work section and bibliography, (2) Project Plan describing the tasks and timelines, (3) Project Briefings presentations in class, (4) Final project presentation, and (5) Final report.

Grading: Semester grades will be computed as follows Assignment/exam	Points %
Term exam	**25%**
Assignments & Project	**75%**
Assignment 1: Project Proposal (10%) Assignment 2: Project Plan (10%) Assignment 3: 1st iteration doc Assignment 4: 2nd iteration doc Assignment 5: 3rd iteration doc Assignment 6: 4th iteration doc Assignment 7: 5th iteration doc (25%)	
Final Project Presentation (15%)	
Final Report (15%)	
Class total	**100%**

Grading scale: Grades will generally be A = 90 – 100%, B = 80 - 89%, C = 70 - 79%, D = 60 - 69%, and F = 0 – 59%. '+' and '-' grade may be reported if the score is near boundary.

Modules	**Course Level Objectives**	**Module Level Objectives**	**Assignments**	**Tentative Activities (To do List)**
Introduction to Cloud Computing and IoT	Course Learning Objective 1	Define key concepts and enabling technologies of Cloud Computing and IoT Explore and define a project topic related to software engineering in Cloud Computing or IoT.	Assignment 1 Discussion & Project Briefing 1	Read Chapters 1&2 of Ref. 1
Virtual Machines and Virtualization of Clusters and Data Centers	Course Learning Objective 1	Define the concept of Virtualization and its different levels Relate Virtualization concepts to cloud computing and IoT	Assignment 2 Discussion & Project Briefing 2	Read Ch. 3 of Ref 1
Cloud Platform Architectures	Course Learning Objective 2	Demonstrate knowledge of the different Cloud Service Models Demonstrate knowledge of specific Platform Architectures	Assignment3 Discussion & Project Briefing 3	Read Ch. 4 of Ref 1 Refs 3, and 5

Cloud Computing Applications Architecture Styles and Patterns	Course Learning Objective 3	Demonstrate knowledge of specific Cloud Computing Application Architecture Styles and Design Patterns	Assignment 4 Discussion & Project Briefing 4	Read Ch. 5 of Ref 1, and Refs 4,5
Cloud & IoT Programming and Software Environments	Course Learning Objective 3	Demonstrate knowledge of specific Programming and Software Environments for cloud and IoT Applications development	Assignment 5 Discussion & Project Briefing 5	Read Ch. 6 of Ref 1, Ch. 7 of Ref 9, and Ref.11
Security and Privacy issues in the Cloud	Course Learning Objective 4	Demonstarte knowledge of specific Cloud of Cloud Security threats and technniques	Assignment 6 Discussion & Project Briefing 6	Read Ch. 4 Sec 4.6, Ref. 1, Ref. 12, 13
Ubiquitous Clouds and the Internet of Things and their applications	Course Learning Objective 4	Demonstarte knowledge of the relation between Cloud Computing and IoT application domains	Assignment 7 Discussion & Project Briefing 7	Read Ch. 9 Ref. 1,

Term Examination: The examination is designed to gauge the student's understanding of topics covered in assigned readings, lectures, and project assignments. The final will be comprehensive. The primary focus will be on all the course material. For the 'take home' exam, students will be given one week to complete the final examination. The Final Exam Rubric will be provided on the exam and discussed in class during the review.

Academic Integrity: Students who practice academic dishonesty, such as cheating or plagiarism, will be penalized. Severe penalties will follow from the discovery of any representation of another individual's work (in any form) as your own (i.e., copying any portion of written assignments or exams). Check the *MLA Handbook for Writers of Research Papers Seventh Edition* (ISBN: 9781603290241) for proper citation of others' work to avoid plagiarism in written assignments. Penalties range from a grade of "zero" on the assignment in question to an "unforgivable F" in the course.
If you have not already done so please go to the website http://www.libraries.wvu.edu/instruction/plagiarism and sign-in as WVU Students-First Time. Use your MyIDusername and password and complete the Tutorial & Take the Test. Please e-mail your certificate for the test to the Software Engineering Program Coordinator, Dale.Dzielski@mail.wvu.edu.
Please refer to the *New Student Orientation Manual for Online Courses* athttp://elearn.wvu.edu/students/images/NewStudentOrientationManual_101910.pdf.
The document provides information on eCampus, Mix, STAR, Help Desk, refund policy, WVU Bookstore and important phone numbers.

Attendance Policy: Students are expected to attend every class. Archives are made available to review if missed due to personal or work related absence that should be communicated with instructor when possible. Consistent with WVU guidelines, students absent from regularly scheduled examinations because of authorized University activities will have the opportunity to take them at an alternate time. Make-up exams for absences due to any other reason will be at the discretion of the instructor.

Inclusivity Statement: The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Accessibility Services (URL http://accessibilityservices.wvu.edu/home; Phone 304 293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see http://diversity.wvu.edu.