# CMSC 491 – Introduction to Cloud Computing
# SYLLABUS

School/College: **College of Engineering**
Department: **Department of Computer Science**
Syllabus Title: **CMSC 491 – Introduction to Cloud Computing**
Meeting Time: **Monday/Wednesday 2:00pm - 3:15pm**
Meeting Place: **Engineering Building West 0104**
Discord Workspace: **https://discord.gg/jG7UNNgN**

## 1. Meet the Professor

### 1.1. Instructor Contact Information:
Title: **Associate Professor**
Name: **Tamer Nadeem**
Office Location: **ERB 2330**
Office Hours:  **Monday, Wednesday – 1:00 pm -2:00 pm**
              **or by appointment**
Email: **tnadeem@vcu.edu**
Work Number:  **804-828-0137**

### 1.2. About the Professor

**Teaching and Education Background**

Dr. Tamer Nadeem joined the department of computer science at VCU as an associate professor in August 2017. He received his Ph.D. degree in Computer Science from the University of Maryland, College Park in 2006. Prior to joining VCU, he was at Old Dominion University (ODU) as an assistant professor and then as an associate professor. Dr. Nadeem has developed and taught several courses such as Wireless Networking and Mobile Computing, App Development for Smart Devices, Introduction to Networks and Communications, Networked Systems Security, and Seminar on Cyber Physical Systems. Dr. Nadeem spent few years as a research scientist at Siemens Corporate Research (SCR) in Princeton, USA in which he led several research projects in the general areas of smart mobility for optimized intelligent transportation systems and dynamic radio management for enterprise and industrial wireless networks.

**Research Interests**

Dr. Nadeem is the founder of Mobile Systems and Intelligent Communication (MuSIC) Lab at VCU. MuSIC lab focuses on several aspect of wireless networking and mobile computing systems including smart wireless systems, mobile and edge computing, software-defined networks, machine learning in networking, network security and privacy, Internet-of-things & smart city systems, vehicular networks, and intelligent transportation systems. His research is funded by several federal agencies and industries including the National Science Foundation, National Institute of Standards and Technology, Federal Highway Administration, Siemens Corporate

Research, AT&T Labs, Microsoft, Nokia-Bell Labs, and Google. Dr. Nadeem holds 5 U.S. patents and has more than 100 publications in peer-reviewed top scholarly journals, conference proceedings, and books. Nadeem serves as a member of the technical and organizing committees of various ACM and IEEE conferences. He is currently serving on the Journal Editorial Board of IET Communications journal and MDPI Sensors.

# 2. Course Information

## 2.1. Course Description

Cloud computing leverages the World Wide Web to fulfill computing needs. It packages applications, computing power, and storage as a metered service similar to a utility. This model is designed to supplant the traditional mechanism of desktop computing in many cases. This course will cover the origin, enabling technology, and tools for key concepts in cloud computing. More specifically, this course aims at undergraduate students providing a practical and programming-oriented introduction to cloud computing with Amazon Web Services (AWS). Students will learn how to build applications using a variety of AWS services, including S3, EC2, Lambda, and ECS. The course will culminate in a final resume-worthy project that will be built, deployed, and demoed.

There are no formal requirements, but it is expected that participants are familiar with computer architecture, basics of computer networks, databases, and programming (C, python, Java). The course will consist of weekly presentations, discussions, hands-on, mid-term exam, and a term project. The class is project oriented in which students, individually, will utilize AWS services in building a project from scratch on AWS, which can be demoed.

## 2.2. Course Overview

This course aims at giving an overview of fundamental concepts, technologies, and applications of cloud computing technology. By the end of this course students should be able to:
- Understand various basic concepts related to cloud computing technologies.
- Understand architecture and concept of different cloud models: IaaS, PaaS, SaaS.
- Explore cloud technologies, architectures, and standards
- Familiarize/Use different cloud services of Amazon Web Services (AWS)
- Familiarize with design methodologies and programming for cloud applications.
- Design/Develop/Deploy cloud applications using Amazon Web Services (AWS)

This course involves of a weekly class presentation of the different materials of the course. Students are highly encouraged to discuss and participate during classes. In addition, the course will have hands-on assignments following specific classes. We will have discussion board in order to facilitate discussions and sharing tips/recommendations between students on the presented materials and hands-on.

The most important component of the course will be the final project. Each student is required to design, develop, deploy, and demo a cloud application independently by the end of the semester. expected to do this project individually (or in groups with instructor approval). A suggested list of cloud applications will be made available by the instructor. In addition, you can come up with your own idea for the application in which you have to run by the instructor for approval. Students are encouraged to think about the application idea early and discuss your ideas with the instructor in order to finalize the objectives and requirements of your cloud application early. A final demo and presentation of your cloud will be due at the end of the semester.

2.3. **Course Meeting**
    **Meeting Time:** Monday/Wednesday 2:00pm - 3:15pm
    **Meeting Place:** Engineering Building West 0104

2.4. **Course Office Hours:**
    **Office Hours' Time:** Monday, Wednesday – 1:00 pm -2:00 pm
                        or by appointment
    **Office Hours' Place:** ERB 2330

2.5. **Course Communication:**
    In addition to office hours, we will use both Canvas Discussions and Discord workspace for questions, discussions, tips, suggestions, on different course related items such as course topics, slides, assignments, hands-on, etc. Questions of general interest should first be posted to either the Canvas Discussions or the Discord workspace (only if they have not already been answered) so that other students can benefit from the response or have an opportunity to respond to your question. Please check these tools first for answers to your questions. Also, feel free to answer posted questions from other students too. Only questions of a private nature should be communicated to instructor through email. In addition, if you do no not get an answer for your question within 24 hours after your post, please feel free to email the instructor directly with your questions.

- **Discord Workspace: https://discord.gg/jG7UNNgN**

- **Canvas Discussions:** Under the course menu on Canvas

- **Email:** tnadeem@vcu.edu

# 3. Course Readings

There is no formal textbook. Several of the presented materials will be adopted from different textbooks and publications. In addition to course slides posted on course' Canvas, a number of relevant reports and documents will be posted under corresponding classes on Canvas.

**Optional textbook:**
- "**Cloud Computing Solution Architecture – A Hands-On Approach**" by Arshdeep Bahga & Vijay Madisetti. VPT Publisher; 1 edition (July 4, 2019). **ISBN-13:** 978-0996025591
- "**Cloud Computing: Concepts, Technology & Architecture**" by Thomas Erl, Ricardo Puttini, Zaigham Mahmood. Prentice Hall; 1 edition (May 20, 2013). ISBN-13: 978-0133387520

## 4. Course Prerequisites

Undergraduate standing in Computer Science, Computer Engineering, or Electrical Engineering. Students are expected to be familiar with: computer architecture, basics of computer networks, databases, and programming (C, python, Java).

## 5. Course Schedule

Table shows class meeting days, topics, and readings. **Dates and topics are subject to change during the course**

| Class Meeting Days | Topics |
|---|---|
| Wednesday, August 25 | Course Logistics: Course structure, grading, project, etc.<br>Course Introduction: What is Cloud Computing, Basic Concepts and Terminologies, Cloud Computing History, Cloud Characteristics. |
| Monday, August 30 | Cloud Fundamentals: NIST Framework, Cloud Pros & Cons, Cloud Delivery Models, Cloud Deployment Models, Cloud Service Model. |
| Wednesday, September 1 | Cloud Technologies & Mechanisms: Internet, Data Centers, Virtualization, Multitenant, Resource Pooling, Scalability& Elasticity, Load Balancing, Service Level Agreement |
| Monday, September 6 | No Class – Labor Day |
| Wednesday, September 8 | Cloud Services & Platforms: Introduction to Basic Cloud Services, Amazon Web Services (AWS), Google Cloud Platform, Microsoft Azure, Cloud Computing Applications |
| Monday, September 13 | AWS Management Console & Billing: The AWS Console, Identity and Access Management, Using the IAM User, Billing and Cost Management Console, Free Tier of Service, Understanding the Free Tiers<br>Acquire An AWS Account |
| Wednesday, September 15 | AWS Compute Services I: Virtualization, Containers, AWS Compute Fundamentals, Amazon EC2, EC2 Instance, Amazon Machine Image (AMI), EC2 Pricing |
| Monday, September 20 | AWS Compute Services II: Amazon CloudWatch, Amazon VPC, EC2 Auto Scaling, Elastic Load Balancing |
| Wednesday, September 22 | AWS Compute Services III: Amazon EC2 Elastic Load Balancing, Amazon Route 53 |

| | |
|---|---|
| Monday, September 27 | AWS Compute Services IV: Network & Web Applications Basics, Text-to-Speech Web Application Example, Amazon ELB |
| Wednesday, September 29 | AWS Networking + AWS Storage Services: Amazon EC2 Elastic Load Balancing, Amazon Route 53, Amazon Simple Storage Service (S3), Amazon Elastic Block Store (EBS) |
| Monday, October 4 | AWS Storage Services II + Python Programming: Amazon Simple Storage Service (S3), Amazon Elastic Block Store (EBS), Python Overview, Python Programming for AWS (Boto3), AWS CLoud9 |
| Wednesday, October 6 | AWS Programming II: AWS Cloud9, Web Services/Applications, Service-Oriented Architecture, Design Consideration for Cloud Services/Applications |
| Monday, October 11 | AWS Programming III: Python Web Application Framework (Django) - Basics, Application architecture, Basic web server |
| Wednesday, October 13 | **Mid-Term Exam** |
| Monday, October 18 | AWS Programming IV: Python Web Application Framework (Django) – Views and Urls |
| Wednesday, October 20 | AWS Programming V: Python Web Application Framework (Django) - Database configuration, Models, Templates |
| Monday, October 25 | AWS Database Services I: Overview of Database Approaches, Database Fundamentals, Amazon Relational Database Service (RDS) |
| Wednesday, October 27 | AWS Database Services II: Amazon Relational Database Service (RDS) - Availability, Security, Backup & Restore, Security |
| Monday, November 1 | AWS Database Services III: Amazon Relational Database Service (RDS) - Monitoring, Pricing, Getting Started with RDS |
| Wednesday, November 3 | AWS Database Services IV + AWS Serverless Applications: Using RDS DB Instance with Django, Serverless architecture, Serverless design patterns |
| Monday, November 8 | AWS Serverless Applications II: AWS Lambda, Amazon API Gateway |
| Wednesday, November 10 | AWS Serverless Applications III: Overview of HTTP Request/Response, API Gateway, Using AWS Lambda with API Gateway |
| Monday, November 15 | AWS Queueing Service: Message Queue Basics, Amazon SQS |
| Wednesday, November 17 | AWS Queueing Service II + AWS Notification Service:  Amazon SQS (cont'd), Publish-Subscribe Basics, Amazon SNS |
| Monday, November 22 | No Class – Fall Break |
| Wednesday, November 24 | No Class – Fall Break |
| Monday, November 29 | AWS Notification Service II + Introduction to MapReduce Programming: Amazon SNS (cont'd), MapReduce Basics |
| Wednesday, December 1 | MapReduce Programming II: MapReduce Programming Concept |
| Monday, December 6 | MapReduce Programming III: Hadoop, Amazon EMR |
| Wednesday, December 8 | AWS IoT Service: Amazon EMR (cont'd), AWS IoT |
| Monday, December 13 | Backup Class |
| **Monday, December 20** | **Final Exam 12:30 pm - 3:20 pm** |

## 6. Course Grading Criteria

### 6.1. Grading

Your grade in this class will be based on the following:

(Note that these percentages are only approximate and are subject to change, but by no more than 10%.)

| | |
|---|---|
| **Class Participation** | **5%** |
| **Hands-on Assignments** | **30%** |
| **Mid-term Exam** | **30%** |
| **Term Project + Presentation + Demo** | **35%** |

Hands-On assignments will be submitted through Canvas following the instructions given in each hands-on assignment. All assignments are due at 11:59:59 PM on the day indicated in the assignment. Assignments may be submitted up to 24 hours late for a 20% penalty. If you submit both on-time and late, your assignment will receive the maximum of the penalty-adjusted scores. Only the last on-time and last late assignments will be graded.

Term-project assignment are expected to be submitted by its due date set by the instructor. No late submission is accepted for the project.

### 6.2. Grading Scale

The grading scale is as follows:
**(+ and - modifiers will be applied as appropriate)**

| | |
|---|---|
| 90-100 = | **A** |
| 80-89 = | **B** |
| 70-79 = | **C** |
| 60-69 = | **D** |
| 0-59 = | **F** |

## 7. Student Responsibilities
(source: One VCU: Responsible Together available at:
https://together.vcu.edu/students/)

When we return, things will look and feel different as we take necessary steps to protect the well-being of our community. Here is what is expected of you:
1. Monitor your health daily. Testing will occur according to protocols.

2. Wear a face covering or mask in common areas, including class.
3. Apply physical distance guidelines to all settings.
4. Clean and disinfect personal and shared spaces before and after use. Cleaning supplies will be available in numerous locations.
5. Report symptoms associated with COVID-19 to VCU Student Health Services. A call center hotline will be available later in the summer.
6. Not sharing is caring during this unique pandemic. Please do not share calculators, tools, lab supplies, etc.

Following rules regarding face coverings or masks, cleaning and disinfecting, and physical distancing is required. Students will receive reminders for daily health monitoring. Staff in the Dean of Students office will be notified after incidents of non-compliance. Refusal to comply with rules can include progressive disciplinary action up to and including suspension, based on the VCU Student Code of Conduct.

## 8. Netiquette Guidelines
(adapted from UWSP)

Netiquette is a set of rules for behaving properly online. Your instructor and fellow students wish to foster a safe online learning environment. All opinions and experiences, no matter how different or controversial they may be perceived, must be respected in the tolerant spirit of academic discourse. You are encouraged to comment, question, or critique an idea but you are not to attack an individual. Working as a community of learners, we can build a polite and respectful course community. The following netiquette tips will enhance the learning experience for everyone in the course:

- Do not dominate any discussion.
- Give other students the opportunity to join in the discussion.
- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Popular emoticons such as ☺ can be helpful to convey your tone but do not overdo or overuse them.
- Never make fun of someone's ability to read or write.
- Share tips with other students.
- Keep an "open-mind" and be willing to express even your academically informed opinion.
- Think and edit before you push the "Send" button.
- Do not hesitate to ask for feedback.
- Using humor is acceptable.

## 9. Tips for Success
- When taking online and hybrid courses, your self-motivation and self-pacing are absolutely critical. For this course, you should plan to work a few hours per course lecture as we move through the materials. Be sure to plan your time accordingly.

- Make yourself a calendar with all of your due dates across ALL of your courses. Plan for when you will work on each one for completion in advance of the due dates.
- Make sure you note any "online" course that still have a required meeting time (such as a Google Meet or Zoom session).
- Avoid the common assumption that online courses are easier or should be easier. That is a MYTH!!
- Plan Ahead!! Study as you go instead of at the last minute!

## 10. Health and well-being
## (from One VCU: Responsible Together)

Navigating the anticipated stressors of daily life can often be challenging enough. When unexpected stressors emerge or when we are faced with uncertainty, it can be tough to know how to cope. Try out some of these tips and resources for health and wellness to see if they are a right fit for you.

### 10.1.    Symptoms or Diagnosis
If an on-campus student identifies symptoms, has tested positive for COVID-19 or has come into contact with someone diagnosed with COVID-19, that student should contact University Student Health Services. At that point, isolation should begin and contact tracing will be performed by Student Health Services. Symptoms will be monitored and the student should refer to a medical provider if symptoms worsen or be released from isolation after 14 days, if symptom-free.

## 11. Course Policies
### 11.1. Attendance
I expect you to attend class and to arrive on time. Your grade may be affected if you are consistently tardy. If you have to miss a class, you are responsible checking the course Canvas to find any assignments or notes you may have missed. Students may leave after 15 minutes if the instructor or a guest lecturer does not arrive in that time.

### 11.2. Computer Account and Email
Students should have a VCU email and Canvas accounts. This will allow you to log into the course's Canvas site. All VCU students automatically receive these accounts, though you may need to activate yours, particularly if you are new to VCU.

Students should activate their VCU e-mail accounts and check them every day. If a student chooses to have his/her messages forwarded to another account, it is the student's responsibility to take the necessary steps to have them forwarded.

All students in this course are responsible for making sure they have working accounts prior to the first assignment.

All students are expected to know and comply with VCU's Computer and Network Use policy, which can be reviewed at https://policy.vcu.edu/universitywide-policies/policies/computer-and-network-resources-use.html

11.3. **Posting Questions and Getting Help**

Questions of general interest should first be posted to either the Canvas Discussions or Discord workspace (only if they have not already been answered) so that other students can benefit from the response or have an opportunity to respond to your question. Feel free to answer posted questions from other students too. Only questions of a private nature should be communicated to instructor through email. When sending a message to me, please allow a minimum of 24 hours for a response. Most of the time I will respond much faster, but sometimes meetings and other courses take over my schedule.

11.4. **Be Proactive in Communication with Instructor**

(adapted from UWSP)

If you find that you have any trouble keeping up with assignments or other aspects of the course, make sure you let your instructor know as early as possible. As you will find, building rapport and effective relationships are key to becoming an effective professional. Make sure that you are proactive in informing your instructor when difficulties arise during the semester so that we can help you find a solution.

11.5. **Tests and Make-ups**

If a situation has occurred that requires your time and attention which will prevent submitting your graded activities on time, please notify your instructor 24 hours before the scheduled due date. It is the student's responsibility to give the instructor a written excuse and to arrange for any makeup work to be done. A makeup exam may be different (and possibly more difficult) than the regularly scheduled exam.

11.6. **Course Disclaimer**

Every attempt is made to provide a syllabus that is complete and that provides an accurate overview of the course. However, circumstances and events may make it necessary for the instructor to modify the syllabus during the semester. This may depend, in part, on the progress, needs, and experiences of the students.

11.7. **Withdrawal**

A syllabus constitutes an agreement between the student and the course instructor about course requirements. Participation in this course indicates your acceptance of its teaching focus, requirements, and policies. Please review the syllabus and the course requirements as soon as possible. If you believe that the nature of this course does not meet your interests, needs or expectations, if you are not prepared for the amount of work involved - or if you anticipate that the class meetings, assignment deadlines or abiding by the course policies will constitute an unacceptable hardship for you - you should drop the class by the drop/add deadline. For more information, please check the Records and Registration page (http://rar.vcu.edu/registration/)

# 12. University Policies

12.1. **College Classroom Conduct**

Please be respectful of your classmates and instructor by minimizing distractions during class. Cell phones must be turned off during class.

12.2. **VCU Statement on Safety**

What to know and do to be prepared for emergencies at VCU:

- Sign up to receive VCU text messaging alerts (http://www.vcu.edu/alert/notify). Keep your information up-to-date.
- Know the safe evacuation route from each of your classrooms. Emergency routes are posted in classrooms.
- Listen for and follow instructions from VCU or other designated authorities.
- Know where to go for additional emergency information (http://www.vcu.edu/alert).
- Know the emergency phone number for the VCU Police (828-1234). Report suspicious activities and objects.

12.3. **VCU Honor System**

(from https://conduct.students.vcu.edu/vcu-honor-system/)

VCU recognizes that honesty, truth, and integrity are values central to its mission to advance knowledge and student success both in the world VCU students will enter, or return to, once they have graduated and in the university community as a microcosm of that world. In a community devoted to learning, a foundation of honor must exist if that community is to thrive with respect and harmony. Therefore, all members of the university community must conduct themselves in accordance with the highest standards of academic honesty, ethics, and integrity at all times.

12.4. **Statement on Americans with Disabilities Act**

Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 require Virginia Commonwealth University to provide an 'academic adjustment' and/or a 'reasonable accommodation' to any qualified individual with a physical or mental disability who self-identifies as having such. Students should contact the Disability Support Services office on the Monroe Park Campus (828-2253) or on the MCV Campus (828-9782) for appropriate academic adjustments or accommodations.

12.5. **Requesting accommodations**

(from One VCU: Responsible Together)

The university recognizes that some students who previously did not need Section 504 Academic Accommodations, and who have a qualifying condition or disability, may need support or assistance during the return to campus process. A modified approach for the temporary and more permanent need for accommodation has been developed and implemented to provide students with full access to programs and activities related to their academic majors. Because every case is different, student requests are evaluated on a case-by-case basis. Please share your need for an

accommodation with the [Student Accessibility and Education Office](), or for MCV Campus students, the [Division for Academic Success](), after you have worked directly with your faculty member.

## 12.6. VCU Guidelines for Student Conduct

VCU faculties play a critical role in helping to build an environment that is conducive to the academic success of our students. As you know, VCU has policies and procedures designed to create an environment conducive to academic excellence. One of these policies and procedures can be found in a document entitled "Guidelines for Faculty Members Regarding Student Conduct in the Instructional Settings." This document is available on the VCU Web at [http://www.students.vcu.edu/studentconduct]().

Understanding these guidelines will help you to encourage classroom behavior that does not detract from the quality of each student's educational experience. Please read the document and think about your role in promoting a University culture based on mutual respect and civility. As a reminder, both faculty and students should turn off cell phones and pagers while in the classroom.

## 12.7. Student email standard

Email is considered an official method for communication at VCU. Students are expected to check their official VCU email on a frequent and consistent basis (the university recommends daily) in order to remain informed of university-related communications. Students are responsible for the consequences of not reading, in a timely fashion, university-related communications sent to their official VCU student email account. Mail sent to the VCU email address may include notification of university-related actions, including disciplinary action. Students must read this standard in its entirety at [https://ts.vcu.edu/media/technology-services/content-assets/university-resources/ts-groups/information-security/StudentEmailStandard.pdf]()

## 12.8. Withdrawal from classes

Before withdrawing from classes, students should consult their instructor as well as other appropriate university offices. Withdrawing from classes may negatively impact a student's financial aid award and his or her semester charges. To discuss financial aid and the student bill, visit the Student Services Center at 1015 Floyd Avenue (Harris Hall) and/or contact your financial aid counselor regarding the impact on your financial aid.

## 12.9. Religious Observances

It is the policy of VCU to accord students, on an individual basis, the opportunity to observe their traditional religious holidays. Students desiring to observe a religious holiday of special importance must provide advance written notification to each instructor by the end of the second week of classes. Instructors are encouraged to avoid scheduling on these dates one-time-only activities that cannot be replicated. Faculty members are expected to make reasonable accommodations to students who are absent because of religious observance through such strategies as providing

alternative assignments or examinations or granting permission for audio or video recordings and the like.

12.10. **Important Dates**

Important dates for the semester are listed in the VCU Academic Calendar: https://academiccalendars.vcu.edu/

# 13. Nondiscrimination policy
(from One VCU: Responsible Together)

VCU is committed to providing a safe, equitable and inclusive environment for all its employees, patients and students. Discrimination or discriminatory harassment is not only unlawful, it is harmful to the well-being of our university community. Our university's core values, specifically those related to diversity and inclusion, have withstood many difficult situations and trying times, and they will not falter now.

Reports of discrimination, bullying, harassment and/or stereotyping of persons of color or those impacted by COVID-19 or otherwise, will not be tolerated. Be assured that VCU will make every effort to address and prevent the occurrence of unlawful discrimination and, if necessary, take prompt and appropriate action to remedy and prevent its reoccurrence. Every member of our community is asked to:

- Become familiar with the university's policies on Preventing and Responding to Discrimination and Duty to Report and Protection from Retaliation in the VCU Policy Library.
- Consult with Equity and Access Services or VCU Human Resources for additional guidance on how to file a report of discrimination.
- Contact the Office of Institutional Equity, Effectiveness and Success (IES) on how to address and maintain a culture of inclusion.
- Encourage individuals who may need an ADA accommodation for a known or newly acquired disability, to contact the ADA/504 Coordinator in ADA Services.
- Bookmark and share information on university or community agencies that offer support or services, such as VCU's Counseling Services or Ombudsperson.
- Explore training and educational opportunities on diversity and inclusion at IExcel Education and through the Office of Institutional Equity, Effectiveness and Success.
- Offer nonjudgmental support and empathy to those affected by current events and this health crisis.

*Students should visit http://go.vcu.edu/syllabus and review all syllabus statement information. The full university syllabus statement includes information on safety, registration, the VCU Honor Code, student conduct, withdrawal and more.*