Department of Computational and Data Sciences

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CDS 230

Modeling and Simulation I

1. General Information

Instructor:	Dr. Hamdi Kavak (hkavak@gmu.edu)
Backup Instructor:	Dr. Carlos Cruz (ccruz1@gmu.edu)
Teaching assistant (STAR):	Mr. Jack Blumstein (jblumste@gmu.edu)
Where:	Innovation Hall 326
When:	Monday, Wednesday 10:30 am - 11:45 am
Assignment submission:	The GMU Blackboard Website (https://blackboard.gmu.edu/)
Course website:	http://hamdikavak.com/course-modsim-1 (under construction)
Video repository:	https://www.youtube.com/channel/UCBijHAVQUO2c9uqCXX3t8Tg
Credits:	3
Recommended Prereq.:	CDS 130
Office Hours:	Wednesday from 2:00 PM - 5:00 pm (COVID policy: **must** email the instructor at hkavak@gmu.edu with your preferred meeting time).

2. Course Description

Modeling and simulation is an emerging engineering discipline that leverages techniques and tools from various other disciplines (e.g., computer science, systems engineering, mathematics) to develop computational models. Such models enable us to create cost-effective, safe, and large scale experimentation capabilities of real-world systems. Modeling and simulation is heavily used in areas such as biology, healthcare, military training and operations planning, transportation, manufacturing, logistics, and aerospace, among others.

This course teaches the fundamentals of modeling and simulation and helps gain the necessary skills for developing computational models of real-world systems. Programming languages are commonly used in simulation model development. In this respect, the first half of the course covers the basic concepts of the Python programming language, which will be used in the second half of the course to develop computational models. Specific modeling techniques to be covered in the second half of the course are dynamical systems, Monte Carlo simulation, and discrete-event simulation.

3. Learning Outcomes

By the end of the course, students will

- have a fundamental knowledge of modeling and simulation,
- be able to write basic Python code,
- be able to create and run basic simulation models,
- gain experience with model development software.

4. Lecture Format

The course will be taught as face-to-face lectures supported by instructional material dissemination through Blackboard and the course website. Per university guidelines, the instructor cannot change the modality of the class from face-to-face to online or hybrid.

5. **Student Privacy**

All course materials posted to Blackboard or other course sites are private; by federal law, any materials that identify specific students (via their name, voice, or image) must not be shared with anyone not enrolled in this class.

- Video recordings of class meetings that include audio or visual information from other students are private and must not be shared
- Live Video Conference Meetings (e.g. Collaborate or Zoom) that include audio or visual information from other students must be viewed privately and not shared with others in your household

6. **Textbooks and Other Instructional Material**

There are no required textbooks for the class because it is difficult to find a single comprehensive book that covers all the topics we will learn throughout the course. Thanks to Dr. Carlos Cruz, we have lecture notes that are helpful for this class. Make sure to download the latest copy before using it. The following is a list of books that you may find helpful:

- Lecture Notes by Carlos Cruz. http://hamdikavak.com/course-modsim-1/lecture_notes.pdf
- Modeling and Simulation in Python by Allen B. Downey. Publisher: Green Tea Press. Free e-book: http://greenteapress.com/modsimpy/ModSimPy3.pdf.
- Learning Scientific Programming with Python (1st edition) by Christian Hill. Publisher: Cambridge.
- Modeling and Simulation Fundamentals: Theoretical Underpinnings and Practical Domains by John A. Sokolowski and Catherine M. Banks. Publisher: Wiley.
- Simulation by Steward Robinson. Publisher: Macmillan International.

Course slides will be provided via the course website. When needed, additional information sources will be listed in the references section of lectures.

7. **Technology Requirements**

Activities and assignments in this course will regularly use the Blackboard learning system and the Zoom communication technology. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent high speed. You can check your speed settings using the speed test software websites.

8. **Safe Return to Campus**

All students taking courses with a face-to-face component are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (https://www2.gmu.edu/safe-return-campus). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week. The COVID Health Check system uses a color code system and students will receive either a Green, Yellow, or Red email response. **Only students who receive a "green" notification are permitted to attend courses with a face-to-face component.** If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class.

Students are required to follow Mason's current policy about facemask-wearing. As of August 11, 2021, **all community members are required to wear a facemask in all indoor settings**, including classrooms. An appropriate facemask must cover your nose and mouth at all times in our classroom. If this policy changes, you will be informed; however, students who prefer to wear masks either temporarily or consistently will always be welcome in the classroom.

9. Course outline (Tentative)

Week of	Chapter	Topic	Assignment
Aug 23	-	**MODULE 1 - Introduction** ● Welcome and Course Overview ● An Introduction to Modeling and Simulation	Homework 0
Aug 30	1, 2	**MODULE 2 - Getting Started with Python** ● Setting Up Your Python Environment ● Variables and Basic Data Types in Python ● Simple Physics Models	Homework 1
Sep 6		**Labor Day - No class on Monday** **MODULE 3 - Control Flow** ● Comparisons, Logic, and Conditional Statements	
Sep 13	3	**MODULE 4 - Strings** ● Strings	Homework 2
Sep 20	3, 4, 5	**MODULE 5 - Collections and Iteration** ● Lists, Tuples, Dictionaries, and Sets ● Loops	Homework 3
Sep 27	6, 11	**MODULE 6 - Making Your Code Organized** ● Functions ● Classes and Object Oriented Programming	
Oct 4	9, 10	**MODULE 7 - Using Third Party Packages** ● NumPy ● Matplotlib	Homework 4
Oct 11		● Example Problems (Oct 12 - **Tuesday**) **MIDTERM EXAM** ● Oct 13 (from 10:30 am - 11:45 am) ● In class	Mid-semester survey
Oct 18		**MODULE 8 - Dynamical Systems** ● Overview of Dynamical Systems ● Ordinary Differential Equations	
Oct 25		● Dynamical Systems Examples **MODULE 9 - Representing Uncertainty in Models** ● Modeling Equal Chances and Pseudo Random Number Generation	Homework 5
Nov 1		● Modeling Unequal Chances ● Example Problems	Homework 6
Nov 8		● Fundamentals of Monte Carlo Simulation ● Monte Carlo Simulation Examples	Homework 7
Nov 15		● Monte Carlo Simulation Examples	

		MODULE 10 - Discrete Event Simulation ● Queuing Systems	
Nov 22		● Introduction to CLOUDES ● Developing CLOUDES Models	Homework 8
Nov 29		● Example Problems	
Dec 8		**FINAL EXAM** ● Dec 8 (Wed from 10:30 am - 11:45 am) ● in class	

10. Grades

Each homework and written exam will be given a numerical grade on a 0-100 scale. Some homework assignments may include bonus tasks which can increase the total score over 100. At the end of the term, the final mark will be totaled as a weighted average according to the following weights:

Average Homework Score	**40%**
Midterm Exam Score	**30%**
Final Exam Score	**30%**

Please note that the average homework score is calculated by dividing the total scores of all homework by the total number of homework assignments. Final grades at the end of the course will be assigned based on the following table, independent of the relative standing in the class.

Final Mark	Corresponding Grade
97.0 or more	A+
94.0 – 96.99..	A
90.0 – 93.99..	A-
87.0 – 89.99..	B+
84.0 – 86.99..	B
80.0 – 83.99..	B-
77.0 – 79.99..	C+
74.0 – 76.99..	C
70.0 – 73.99..	C-
60.0 – 69.99..	D
less than 60.0	F

11. Exams

The course includes mandatory midterm and final exams. You are responsible for all the content covered before the exam. Both the midterm and final exam will be conducted on paper. There will be no group work in the exam. You're not allowed to use other communication technologies. The honor code will be in effect in ensuring that all work turned in will be your own and that you followed the exam rules.

A student who cannot write a course examination or complete a course homework because of an incapacitating illness, severe domestic affliction, or other compelling reasons can apply for an extension of time. Note that such extensions will be evaluated case by case. There is no guarantee that the instructor will grant the extension.

12. General guidelines for homework preparation and submission

- All homework assignments are mandatory unless otherwise noted. A single homework may involve a combination of questions requiring you to write Python code and textual answers. Homework assignments are always due Sunday midnight (usually 7 days after the lecture).
- Grades of assignments will be based on conciseness and completeness of your answers. Please write to the point and explicitly address the question or task. Avoid using unnecessary graphics (figures, tables, graphs) unless they serve a specific purpose.
- Programming assignments:
  - should be submitted as a single Python (.py or .ipynb) file per homework named according to the format: firstname_last_name_HW_X.py or firstname_last_name_HW_X.ipynb. For instance, if I am turning in Homework 4, then my file name should be "hamdi_kavak_HW_4.py" or "hamdi_kavak_HW_4.ipynb".
  - please use homework templates (jupyter notebook or .py) located on the course website under the "References" section.

- In case more than one file needs to be submitted, you should submit a single ZIP file containing all the assignment files.
- Please make sure you have a backup of all the materials you submit.
- Assignments should be submitted **through the Blackboard course website**. Every assignment should allow you to submit the work multiple times up until the deadline. The last version of the assignment will be graded. If you turn in a newer version of your homework, you must include ALL files associated with that homework.

Please note: Assignments should be submitted only through the Assignment submission section of the Blackboard system - DO NOT email assignments directly to the instructor.

13. Make-up work

Assignments submitted **within 48 hours after the due date will get -10 pts**. Assignments submitted more than **48 hours after the due date will get 0.** If a student is ill or quarantined, make-up opportunities may be given.

14. Attendance

Attendance is not part of the grade but highly encouraged.

15. Snow-day policy

Since this course will be taught completely online, we will continue the instruction regardless of the weather conditions. Even if the university is closed, we will have our classes as scheduled. Students can resume snowball fun after class.

16. Military activation policy

If you are a military personnel and called on duty during the semester, check GMU's military activation policy at https://military.gmu.edu/military-mason/military-activation-policy.

17. Course website

The course has two websites: the public website and a Blackboard website. The public website provides all the content and organization needed for this class. The Blackboard website provides you a portal through which you may retrieve assignment data and review links to additional materials, and receive special announcements. You are required to visit the course website regularly and follow all announcements. Please notify the instructor if you notice any problems accessing the public website.

18. Electronic communication, office hours and support

All course-related submission of assignments should be made through the course Blackboard website. Please **DO NOT** email your assignment submissions to the instructor or STARs unless the Blackboard website is down for an extended period.

Students are encouraged to contact the STARs and the instructor for any questions regarding the course content. The ideal time to contact the instructor for such inquiries is the office hours which is provided under General Information. The instructor will notify the students via GMU email if there are any temporary changes in office hours. For other times, students must contact the instructor via email to schedule an online appointment. Ideally, the instructor will respond to course-related student emails within 2 business days. If you include "[CDS 230]" in the email subject, it will help to accelerate the response time.

19. Students with disabilities

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit http://ds.gmu.edu/ for detailed information about the Disability Services registration process. Then please discuss your approved accommodations with me. Disability Services is located in the Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu | Phone: (703) 993-2474

20. Expectations from students

- *Academic Integrity:* Students must be responsible for their own work, and students and faculty must take on the responsibility of dealing explicitly with violations. The tenet must be a foundation of our university culture. [See http://academicintegrity.gmu.edu].
- *Honor code:* Students must adhere to the guidelines of the George Mason University Honor Code. [See https://oai.gmu.edu/mason-honor-code/].
- *MasonLive/Email (GMU Email):* Students are responsible for the content of university communications sent to their George Mason University email account and are required to activate their account and check it regularly. All communication from the university, college, school, and the program will be sent to students solely through their Mason email account.
- *University Policies:* Students must follow the university policies (See http://universitypolicy.gmu.edu) including the Responsible Use of Computing [See https://universitypolicy.gmu.edu/policies/responsible-use-of-computing/).
- *Class behavior:* Cell phone usage is not allowed in class. In urgent cases, the student can leave and use the phone outside of the class. Eating any sort of food should be avoided.

21. Frequently asked questions

- *What software do we need?*
  This course will use Python version 3.7 (or later) distributed via Anaconda

(https://www.anaconda.com/distribution/). Students are welcome to install other python distributions of their choice as long as the version number matches.

- *What are the required knowledge and skills to be successful in this course?*
  This course has a recommended prerequisite of CDS 130 which touches upon some programming concepts. So, you are expected to have some basic computing skills like running a program and doing some basic calculations. However, you are not required to master in any programming languages, including Python. It is to your advantage in this class and in your career if you acquire computing skills. Additionally, you will be asked to **transcribe** some mathematical equations (i.e., models) of real world systems to Python code in assignments and exams. This does **not** require you to solve or memorize equations.

- *Have another question?*
  Ask the instructor via email. If your question applies to all students, it will be shared here as well.

Disclaimer: Any typographical errors in this Course Outline are subject to change and will be announced in class. The date of the final examination is set by the Registrar and takes precedence over the final examination date reported by the instructor.

Notes: (1) Recording is permitted only with the prior written consent of the professor or if recording is part of an approved accommodation plan. (2) The format and template of this syllabus is prepared based on the syllabus of Dr. Andreas Zufle's GGS 787 - Scientific Data Mining for Geo-informatics 2018 course. A partial content of this syllabus is adopted from the syllabus of Dr. Jason Kinser's CDS 230 - Modeling and Simulation 1 - Summer 2017 course.