Chem 283
MSSE Capstone Project Course
Syllabus

Spring 2022
Instructor: Tony Drummond, LADrummond@berkeley.edu (tentative)

Course Description:
The main course objective is to provide MSSE students with a multifaceted experience managing a project of their choice involving the application and development of high-end computational software for Computational Sciences with emphasis on Molecular Sciences. Students will exercise their leadership and team building skills through individual class assignments, peer reviews and a final Capstone project report.
The Capstone project is an essential part of the MSSE program because students get to transfer skills learned in other MSSE courses to a real-world application. Capstone project proposals have the expectation that students will apply several software engineering, algorithmic and scientific concepts and techniques learned during the MSSE program.
Another important aspect of this course is to provide students with professional networking opportunities. Students may choose to work on a project for a given company or a project with one of MSSE's industrial and academic partners. This course is also designed to be tightly integrated with MSSE Leadership Bootcamp, which MSSE students will undertake in their final weeks of the MSSE program. During the Leadership Bootcamp, students will build up on their Capstone projects to practice entrepreneurship and leadership skills.
MSSE students work on Capstone projects either individually or within cross-functional teams. In either case, all work in this course will be submitted individually, and students working within a team will have a predetermined set of deliverables and responsibilities.
This course is designed to provide students with tools and practices designing project deliverables, planning and meeting project deadlines, giving presentations, writing technical communications and providing constructive feedback to peers. They will be supervised to complete building a professional MSSE software portfolio, which meets the best software engineering practices.

Capstone Project Tracks:
Given the wide variety of student backgrounds, professional interests and Computational Sciences topics covered in the MSSE program, the Capstone projects will be classified in one of the following three professional interdisciplinary tracks;
- **Scientific Problem.** A Capstone Project focuses on the research and development of a computational science application. The product is a publication quality research paper in a computational sciences journal or conference. Results need to be reproducible.
- **Large Scale Computing.** A Capstone Project focuses on the development of large scale software tools or computational applications relevant to Molecular Sciences.   The product includes a software package, corresponding documentation, computational scalability analysis, and scientific relevance of the accomplishments. The product is a publishable research paper in a high-performance computing journal or conference. Results need to be reproducible.
- **Software Engineering and Algorithms**. Work focuses on the development of a library or software package for computational sciences. The final product is a high-quality software package, well documented and integrates relevant auto-tests, examples, and user interfaces.   The product is a software package that can be distributed and maintained through a widely available software repository (i.e. GitHub, GitLab, etc)

Course Learning Objectives and Outcomes:
The Capstone Project course has been designed to provide MSSE students with a supervised experience transferring concepts and techniques learned in other MSSE courses to the practical and professional environment required by a Capstone project. Specifically, the course uses a set of holistic Learning Objectives as metrics to evaluate the progress made by a student during the 15 weeks of the course (14 weeks instruction and 1 week final project presentation), and onto essential skills that will be mastered during the MSSE Leadership Bootcamp.

The Learning Objectives are:
- **LO1:** Write a project description with a gap analysis and project justification
- **LO2:** Write a technical project proposal
  - **LO2a**: Write a technical description of the problem or challenge to be addressed
  - **LO2b**: Write technically sound solutions for the problem or challenge to be addressed
  - **LO2c**: Write descriptions of milestones and deliverables
  - **LO2d**: Identify sources of information and expertise (e.g. experts in the field, supervisors, articles, videos, data)
- **LO3:** Apply fundamentals of software project management, including use of software productivity tools. Build a Software portfolio
- **LO4:** Apply best software engineering practices
- **LO5:** Work experience within cross-functional teams
  - **LO5a:** Provide constructive feedback to peers, both technical and managerial
  - **LO5b:** Incorporate feedback from peers and supervisors into their project design and implementation
- **LO6**: Transfer technical concepts and techniques learned during the MMSSE program
- **LO7:** Communication effectively when negotiating deliverables and submitting deliverables, and presenting in a professional setting
- **LO8:** Mitigate project risks and points of failures
- **LO9:** Write periodic project updates, including deliverable status and self assessment.
- **LO10:**Write final project report and submit deliverables

Course Outcomes:
At the end of this course, students will be able to:
- Transfer and apply software engineering principles, data science and molecular sciences concepts and algorithms to a real-world application.
- Write a project proposal highlighting project objectives and justification
- Write a description of project deliverables including a sound plan of action to complete the deliverables and project
- Curate technical sources of information including field experts and technical materials.
- Use Software productivity tools to establish a project plan, manage/participate in a project and assess project performance
- Effectively communicate, negotiate project deliverables.
- Apply basic skills for effective cross-functional team work.
- Analyze projects and identify possible points of failure and recovery solutions.
- Write and communicate project update and final reports

Grading:

Although Capstone projects can be individual or group projects, students are evaluated individually based on their individual role in a group project, individual submissions of project reports, participation in group check-ins, and individual management of their project tasks and presentations.

The table below describes the eight different components of a Capstone project grade. First, students will submit a draft project proposal which is based on a preparation 1-1 session between students and Capstone Course faculty during the Fall term. Assignments 1-5 are developed in close supervision with Capstone Course faculty. Technical soundness of the project will be assessed by external experts in the project, MSSE and Capstone faculty. Assignment 6 is a portfolio of all software products that the students developed throughout the MSSE curriculum. During the MSSE Introduction Bootcamp students are taught how to set up and maintain a software repository. Then they learn how to incorporate best software engineering practices in CHEM 274A and CHEM 274B.

Lastly, the Capstone Project presentations will provide opportunities for students to present their work to peers, MSSE faculty, and strategic MSSE partners. Specifically, students will use the Leadership Bootcamp to work on their presentation skills before presenting in front of a wider audience of industrial and academic MSSE partners.

Assignments	% of Grade	Assignment Description	Learning Objectives*
Draft Proposal	5%	Pre-proposal requirement for the course. Students identify the project's topic and Capstone Project Track, technical sources, write brief project descriptions and deliverables.	LO1, LO2d
Assignment 1	10%	Students submit a revised version of the draft proposal after receiving feedback and reviews from faculty.	LO1, LO2, LO3
Assignment 2	10%	Students submit a project update focusing on the plan for completion of deliverables.	LO1, LO3, LO6, LO7
Assignment 3	15%	Students evaluate projects from peers and provide written constructive feedback. They gather feedback from external advisors/supervisors and react to feedback received from supervisors and peers.	LO3, LO4, LO5, LO6, LO7, LO8
Assignment 4	10%	Students submit a draft of their project report, deliverables, and details on its plans for completion.	LO2, LO3, LO4, LO5, LO6, LO7, LO8, LO9
Assignment 5	30%	Students submit their final project reports and deliverables by the deadline. Notice that project deliverables are dictated by the Capstone Project Track.	LO3, LO5, LO6, LO7, LO8, LO9, LO10
Assignment 6	10%	MMSSE Software Portfolio	LO3, LO4, LO6
Capstone Project Presentation	10%	Students present their projects to the class and guest collaborators (e.g. supervisors/advisors).	LO3, LO4, LO5, LO6, LO7

Course Structure and Schedule:
This course is designed as a 15 weeks of synchronous and asynchronous lectures, project check-ins with Capstone faculty and with final project presentations during the last week of the semester. The learning outcomes and products of the course are prerequisites for the MSSE Leadership Bootcamp, where students will improve their Capstone project solutions using a business oriented lens. This course focuses on 5 different phases of a software development project as detailed below.

Every week, students participate in a series of synchronous and asynchronous lectures and check-in sessions. Asynchronous lectures will provide students with reading materials and instruction to support their project management and development. The synchronous check-ins will be either Capstone faculty-led lectures, reviews, updates and Q&A sessions, or Capstone group led sessions in which students will provide and receive feedback from peers. Capstone faculty will hold weekly office hours. Capstone faculty will collect feedback from field experts and supervisors twice during the course.

Capstone Cross-Functional Teams and Groups.
Students will be organized in cross-functional teams and Capstone groups. A cross-functional team is a group of students working on the same Capstone project and each team member has a different role in the team. A Capstone group can be made of members of a cross-functional team, a group of students working on individual projects, or a combination of teams and individual projects. Capstone groups will be determined the first week of the course and their purpose is to improve the students ability to provide and gather technical feedback from peers, and also incorporate technical feedback received into their projects.

PREPARATION PHASE: Introduction to Capstone Projects and Tracks.
This is a project exploration phase in which students will meet with Capstone Course faculty to identify possible project interests, Capstone project track, and identify Capstone project teams, when necessary. Students will receive enough information about the project before the first class of the course. A draft proposal is due the first day of class. Students will also have a meeting with MSSE Leadership Bootcamp faculty to gain some perspective on the Business aspects of the projects and professional advice.
Learning Objectives: LO1 and LO2d *(see the descriptions of learning objectives above)*

- September 2021: 1-1 Student Sessions with Capstone Faculty
  - A brief overview of the Capstone Project
  - Review student interests and available projects
  - Software Portfolio
  - Introduce the concepts of Cross-Functional Teams and Capstone Groups

- November 2021: Group Session with MSSE Leadership Bootcamp
  - Practical advice on Capstone project management from a business point of view

- December 2021: Group Session with Capstone Faculty (pre-proposal)
  - Preparing a Capstone project draft

PHASE I: Project Set Up and Proposal Acceptance.
The first phase of the Capstone Course focuses on refining the scope of the project and its deliverables. Students will learn essential skills for writing a technical project proposal and its deliverable agreements, defining functional teams within a project and accountability for the individual team members, negotiating project deliverables and deadlines.
Students will bring a draft proposal due the first day of course and complete this phase with signed project agreements which includes a list of their project responsibilities and tasks, and a list of responsibilities and deadlines.
Learning Objectives: LO1, LO2, LO3, LO6 and LO7

WEEK	CAPSTONE COURSE ACTIVITIES	DEADLINES

1/17-21/2022	Asynchronous Session (released by 1/10/2022):
	● Review of selected readings on Project Management (WRK)
	● A guide to Software Productivity tools (WRK)
	● Collaborative and functional project teams (WRK)
	Synchronous Sessions:
	● Group Check-in w/o Faculty: 1/18/2022
	  ○ Finalize Capstone groups
	● Check-in with Faculty 1/20/2022:
	  ○ Capstone Projects Learning Objectives
	  ○ Capstone Project Tracks, Individual vs. Team projects
	  ○ Project proposals and functional team reviews
	  ○ Clear deliverables, work expectations and planning
	
	Readings: Wysocki Chapter 1 and 2.
	Office Hours: 1/21/2022
		Draft project Proposal 1/18/2022

1/24-28/2022	Asynchronous Session (released by 1/10/2022):
	● Build Self-Awareness with Help from Your Team (HBR Coursepack)
	● How to Plan a Project (WRK)
	● Technical and Academic Soundness
	
	Synchronous Sessions:
	● Group Check-in w/o Faculty: 1/25/2022
	● Check-in with Faculty 1/27/2022:
	  ○ Project planning and meeting deadlines
	  ○ Project risk assessment including analysis of requirements and dependencies
	  ○ Field experts, reference materials and project and work agreements
	
	Readings: Wysocki Chapter 4 and Chapter 5
	Office Hours: 1/28/2022
		Assignment #1 1/27/2022

PHASE II: Project Launch and Management.		
This phase students launch their projects, work on writing project periodic reports and status updates. Set up and work with a Software Productivity Tool, review technical approaches and meet first project deadlines. **Learning Objectives**: LO1, LO3, LO4, LO5, LO6, LO7, LO8, and LO9		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**

1/31-2/4/2022	Asynchronous Session (released by 1/17/2022):
	● Report on Early Lessons Learned
	● Identify software dependencies and requirements
	● Identify functional team dependencies
	● Identify sources of expertise
	
	Synchronous Sessions:
	● Group Check-in w/o Faculty: 2/1/2022 and 2/3/2022
	  ○ Review/Updates on project planning and meeting deadlines
	  ○ Capstone Project management team work
	  ○ Capstone project task synchronization and review
	
	Reading: Wysocki Chapter 8 and Chapter 9
	Office Hours: 2/4/2022	

2/7-11/2022	Asynchronous Session (released by 1/17/2022):
	● Updating and coordinating team/group project plans
	● Writing periodic project reports
	● Review best Software Engineering practices
	● Students receive feedback from Faculty on Assignment#1 (released on 2/4//2022)
	
	Synchronous Sessions:
	● Check-in w/o Faculty 2/8/2022
	  ○ Review feedback from Capstone Faculty
	  ○ Prepare to submit Assignment #2
	● Check-in with Faculty 2/10/2022
	  ○ Providing and receiving constructive feedback
	  ○ Incorporating feedback effectively from peers into project
	
	Office Hours: 2/11/2022
		Assignment #2
		2/10/2022

PHASE III: Mid-Project Review: Peer Reviews and Project Updates. Students work on preparing a mid-project report. They will assess their projects with Capstone Groups, review plans for completion. Peer feedback is provided through Capstone groups and external MSSE collaborators or supervisors. **Learning Objectives:** LO1, LO3, LO4, LO5, LO6, LO7, LO8 and LO9		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**
2/14-18/2022	Asynchronous Session (released by 1/31/2022): ● Providing and Receiving Constructive Feedback part II ● Planning and Organizing peer reviews ● Gathering feedback from field experts ● Software testing and validation Synchronous Sessions: ● Check-in w/o Faculty 2/15/2022 ○ Students meet in Capstone groups to plan peer review process Office Hours: 2/18/2022	
2/21-25/2022	Asynchronous Session (released by 2/18/2022): ● Student received feedback from Capstone Faculty on Assignment#2 Synchronous Sessions: ● Check-in w/o Faculty: 2/22/2022 ○ Review feedback from Capstone Faculty ○ Provide progress updates ○ Receive peer and expert feedback ● Check-in with Faculty: 2/24/2022 ○ Projects updates and Q&As Office Hours: 2/25/2022	
2/28-3/4/2022	Asynchronous Session (released by 2/14/2022): ● Project management and updates part I Synchronous Sessions: ● Check-in w/o Faculty: 2/29/2022 ○ Provide progress updates ○ Receive peer feedback ○ Share feedback received from external supervisors Office Hours: 3/4/2022	Student provide written feedback to peers 3/3/2022

PHASE III: Mid-Project Review: Peer Reviews and Project Updates *(cont.)* **Learning Objectives:** LO1, LO3, LO4, LO5, LO6, LO7, LO8 and LO9		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**

3/7-11/2022	Asynchronous Session (released by 2/14/2022):
	 ● Project management and updates part II
	 ● Risk Identification and Mitigation part I
	
	 Synchronous Sessions:
	 ● Check-in w/o Faculty: 3/8/2022
	   ○ Provide progress updates and actions on peer
	     reviewed feedback
	 ● Check-in with Faculty 3/10/2022
	   ○ Capstone progress reports
	   ○ Review technical feedback from field experts and
	     impact on student projects.
	
	 Office Hours: 3/11/2022
		Assignment #3
		 3/11/2022

PHASE IV: Project Assessment and Plans for Completion. Based on feedback received on the midpoint project review, students re-assess their Capstone projects, lists of deliverables and plans for completions. As students work on their particular project deliverables, they learn how to mitigate risks, assess the technical quality of their products, and report on the lessons learned. At the end of this phase, students get an opportunity to submit a draft of their final project for early feedback. **Learning Objectives:** LO1, LO3, LO4, LO5, LO6, LO7, LO8, LO9 and LO10		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**

3/14-18/2022	Asynchronous Session (released by 2/28/2022):
	 ● Project management and updates part III
	 ● Risk identification and Mitigation part II
	
	 Synchronous Sessions:
	 ● Check-in w/o Faculty: 3/15/2022
	   ○ Review feedback from Capstone Faculty
	   ○ Provide progress updates
	   ○ Risk identification and mitigation
	   ○ Receive peer and expert feedback
	
	 Reading: Wysocki Chapter 10
	 Office Hours: 2/25/2022	

3/21-25/2022	***Spring Recess***	

PHASE IV: Project Assessment and Plans for Completion *(cont.)* Learning Objectives: LO1, LO3, LO4, LO5, LO6, LO7, LO8, LO9 and LO10		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**
3/28-4/1/2022	Asynchronous Session (released by 3/21/2022): ● Student received feedback from Faculty on Assignment#3 Synchronous Sessions: ● Check-in w/o Faculty: 3/29/2022 ○ Review feedback from Capstone Faculty ○ Provide progress updates ○ Risk identification and mitigation ○ Receive peer feedback ● Check-in with Faculty: 3/31/2022 ○ Project updates and revision of deliverables ○ Identify project highlights, successes and challenges Office Hours: 4/1/2022	
4/4 - 8/2022	Asynchronous Session (released by 3/21/2022): ● Gearing up for the project completion - Part I ● Software Release and Distributions Synchronous Sessions: ● Check-in w/o Faculty: 4/5/2022 ○ Provide progress updates ○ Review Individual software releases and deliverables ○ Receive peer feedback	Assignment #4 4/8/2022
PHASE V: Project Completion and Final Presentation. This is the last phase of the Capstone project. Students work on completing their projects, deliverables, oral presentation skills, final Capstone project report, and software portfolio. **Learning Objectives:** LO1, LO3, LO4, LO5, LO6, LO7, LO8, LO9 and LO10		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**
4/11 - 15/2022	Asynchronous Session (released by 3/21/2022): ● Gearing up for the project completion - Part II Synchronous Sessions: ● Check-in w/o Faculty: 4/12/2022 ○ Provide progress updates ○ Review Individual software releases and deliverables ○ Receive peer feedback ● Check-in with Faculty: 4/14/2022 ○ Project completion plans ○ Gathering feedback from field experts	

PHASE V: Project Completion and Final Presentation *(cont.)* **Learning Objectives:** LO1, LO3, LO4, LO5, LO6, LO7, LO8, LO9 and LO10		
WEEK	**CAPSTONE COURSE ACTIVITIES**	**DEADLINES**

4/18 - 22/2022	Asynchronous Session (released by 3/21/2022):
	 ● Students received feedback from Faculty on Assignment#4
	
	 Synchronous Sessions:
	 ● Check-in w/o Faculty: 4/19/2022
	   ○ Provide progress updates
	   ○ Review Individual software releases and deliverables
	   ○ Review project feedback from faculty	

4/25 - 29/2022	Asynchronous Session (released by 4/11/2022):
	 ● Final Capstone Project report and deliverables
	
	 Synchronous Sessions:
	 ● Check-in w/o Faculty: 4/26/2022
	   ○ Provide progress updates
	   ○ Review Individual software releases and deliverables
	   ○ Receive peer feedback
	 ● Check-in with Faculty: 4/28/2022
	   ○ Review feedback from Capstone faculty prior to Leadership Bootcamp
		Assignment #5
		 4/29/2022

5/2 - 7/2022	Asynchronous Session: Overview of Best Software Practices for releasing software ● Reading, Review and Recitation Week Office Hours: 5/6/2022	
5/9-13/2022	Synchronous Sessions: 5/9-5/13 3:00 AM - 5:00 PM ● Capstone Project presentations with invited collaborators and strategic partners	Assignment #6 5/9/2022 Presentation Slides due 5/9/2022

Prerequisites:

All courses in the MSSE program curriculum are prerequisite of the Capstone Project course. Students need to simultaneously register for the Applications of Parallel Computers and Leadership Bootcamp courses.

Course Materials:
- **[Required]** Selected sections from: Wysocki, Robert K (2019): *Effective project management: Traditional, Agile, Extreme*. JOHN WILEY & Sons, Eighth edition.
- **[Required]** Selected readings for the class will come from the *Harvard Business Review Coursepack.* This ClassPack has been curated in collaboration with the Leadership Bootcamp.
- **[Required]** Students identify the technical sources and references for their particular projects.
- **[Optional]** Documentation on Software Productivity Tools

Attendance Policy:
The synchronous check-in sessions are key to assess the students' work and progress during their Capstone project development. Students are expected to participate in all synchronous check-ins during the semester which are important to support the cross-functional teams and Capstone groups. Students are expected to attend the sessions on time. Late arrivals will impact student grades and their professional presentation. Absences will need to be excused and the students will need to write a professional justification with specific plans on how they plan to address the impact of their absence on the Capstone group and cross-functional team, when applicable.
All students are required to attend the synchronous sessions and Leadership Bootcamp during the last two weeks of the course and they need to be present during all presentations by their peers.

Late Assignment Policy:
If you turn in an assignment after the deadline, you will automatically lose 15% of your total grade for that assignment.

Honor Code & Academic Integrity:
The community at UC Berkeley has adopted the following Honor Code: "As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others." We should all strive to live up to this ideal and support others to do so as well. You should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. So be proud of your academic accomplishments and help to protect and promote academic integrity at Berkeley. The consequences of cheating and academic dishonesty – including a formal discipline file, possible loss of future internship, scholarship, or employment opportunities, and denial of admission to graduate school – are simply not worth it. Anyone caught cheating in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct.

Collaboration and Independence:
Unless otherwise instructed, homework assignments are to be completed independently and materials submitted as homework should be the result of one's own independent work.

Plagiarism & Ethics:
To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, consult these two resources for examples:
- **Academic Misconduct: Cheating, Plagiarism, and Other Forms**
- **Cite Sources**

Students with Disabilities:
If you need accommodations for any physical, psychological, or learning disability, please contact Heather Makiharju, Student Services Advisor at hmakiharju@berkeley.edu, or the **Disabled Students' Program**. An "individual with a disability" means any person who has a physical or mental impairment, which substantially limits one or more major life activities, who has a record of such an impairment, or who is regarded as having such an impairment.

Accommodation of Religious Creed:
It is the official policy of the University of California, Berkeley to permit any student to undergo a test or examination, without penalty, at a time when that activity would not violate the student's religious creed, unless administering the examination at an alternative time would impose an undue hardship that could not reasonably have been avoided. Requests to accommodate a student's religious creed by scheduling tests or examinations at alternative times shall be submitted directly to the faculty member responsible for administering the examination. Reasonable common sense, judgment, and the pursuit of mutual goodwill should result in the positive resolution of scheduling conflicts. The regular campus appeals process applies if a mutually satisfactory arrangement cannot be achieved.

Disclaimer:
This syllabus is subject to change at any time by the instructor. Every effort will be made to give students ample notification of any changes.

The information below is only for the system.

Course Description Summary (750 characters):
This course provides students with a multifaceted experience managing a project involving the application and development of software for Computational Sciences. Students exercise leadership, team building, and critical thinking skills resulting in a Capstone project deliverables and final report.
Capstone projects are an essential part of the MSSE program because students transfer skills learned in other MSSE courses to a real-world application in particular applying several software engineering, algorithmic and scientific concepts.
This course is also designed to be tightly integrated with MSSE's Leadership Bootcamp.
Capstone projects are developed with MSSE industrial and academic partners, individually or in cross-functional teams.

Capstone Course Justification (1,000 characters max):
The Capstone project is an essential part of the MSSE program because students are coached to transfer skills learned in all other MSSE courses to a real-world computational application. Further, in the Capstone project course students are expected to apply several software engineering, algorithmic, scientific concepts and techniques into the solution of computational problems.

In addition, this course provides students with professional networking opportunities. Students may choose to work on a project for a given company or a project with one of MSSE's industrial and academic partners.

Lastly, in this course students will exercise their leadership, team building, critical thinking skills through individual class assignments, peer reviews and a final project report.   Students learn essential tools and practices to manage software projects and their deliverables, meet project deadlines, provide constructive feedback, produce technical and professional written and oral communications.