Spring 2024

CHE 632-852: Communicating with Chemical and Materials Engineering

Richard Cimino

Visual Communication with Chemical and Materials Engineering Data/CHE 632 Syllabus

Spring 2024

Course Modality:

This is an online course, which will be conducted fully online, asynchronously via Canvas. For more information on using Canvas and other supported learning tools, visit the IST Service Desk Knowledgebase.

Instructor Information

Instructor	Email	Office Hours
Dr. Richard T. Cimino	cimino@njit.edu	Schedule office hours

I do my best to respond to all emails/Inbox messages within 24 hours on weekdays. Messages sent over the weekend may not receive a response until Monday morning. Quizzes, homework, and discussions will be graded weekly. Please note that Office Hours appointments must be scheduled at least 24 hours in advance of the scheduled meeting time.

General Information

Course Description

This course will focus on training students to communicate data relevant to chemical and materials engineering and related professions. Students will learn both the theoretical and practical aspects of data communication, including visualization aesthetics and design principles, as well as how to critically analyze and interpret engineering data. Throughout the course, students will also gain a broader understanding of data visualization best practices and how data can be used to enhance engineering analysis, using digital tools. A special emphasis will be placed on making engineering data accessible to all individuals, using the principles of Universal Design. Students will incorporate each of these design principles into a capstone multimedia course project.

Prerequisites/Co-requisites

BS degree in chemical, mechanical, electrical or biomedical engineering or in physics or chemistry, or related/equivalent experience.

Course Learning Outcomes

By the end of the course, students will be able to:

1. Utilize principles of aesthetics and visual design elements to generate effective visualizations of chemical and materials engineering data.
2. Employ the visual design process and principles of Universal Design to communicate engineering data usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.
3. Visualize spatial, temporal and multivariate engineering data.
4. Visualize neural networks and other cluster-based datasets.
5. Compare and identify effective data visualization methods for specific engineering applications.
6. Utilize digital tools to visualize chemical and materials engineering data using statistical analysis.
7. Test statistical models for training error and perform residual analysis.
8. Apply Root-Cause Analysis (RCA) to inform chemical engineering design decisions.
9. Evaluate and mitigate bias in chemical and materials engineering data models using digital visualization tools.
10. Prepare an effective technical report describing design project goals, progress, and results.
11. Disseminate results through oral presentations to classmates.
12. Formally critique professional engineering oral and written communication.

Required Materials

Required Texts:

- Ward, Matthew, O. et al. *Interactive Data Visualization*. Available from: VitalSource Bookshelf, (2nd Edition). Taylor & Francis, 2015.

- Kirk, Andy. *Data Visualisation*. Available from: VitalSource Bookshelf, (2nd Edition). SAGE Publications, Ltd. (UK), 2019.

Occasionally, supplemental readings from outside the main textbook will be provided to you throughout the course.

Visualization Software: You are encouraged to use any visualization software that you are comfortable with. There are many ***freely available and user-friendly*** 2D data visualization tools on the internet, such as: Flourish, RawGraphs, Datawrapper, Xmdv, and Canva. Please note, some of the tools mentioned above require you to create a free account.

Google's Sheets and Slides programs are free with a Google Account. Other common visualization tools that are licensed (i.e. may require payment) are MS Excel & PowerPoint.

In the second half of the course, you will need to use either MATLAB or Python, which also have extensive 2D and 3D visualization functionalities. Instructions on how to download and install MATLAB and Python will be provided to you.

Grading Policy

NJIT Grading Legend

Final Grade Calculation

Final grades for all assignments will be based on the following percentages:

Homework Assignments	**30%**
Discussion Forums	**15%**
Project Update Presentations (x2, 5% each)	**10%**
Weekly Project Deliverables	**30%**
Capstone Project Report	**15%**

Course Work

Homework Assignments: (30% of grade) Each week you will be assigned a homework assignment that will contribute to your personal design portfolio. As such, these assignments are to be completed individually. Assignments should be submitted as pdf documents with an engineering memo portion which should preface the assignment (the Engineering Memo format we will use for this course is in Canvas). Each homework assignment is due at 11:59pm the Friday of the week it is assigned. Assignments which require coding or numerical calculations should be fully documented. If any coding is submitted, the code should be easily digestible and well commented, and any discussion should be clearly written.

Discussion Forums: (15% of grade) You are expected to participate in weekly discussion forums in Canvas. When all students participate in a discussion, it creates an active learning environment that will help you better understand the materials and be more successful in the class. Every week a short topic for discussion about a visual communication topic, article, or problem will be posted on the discussion board. Your responses will count towards your discussion grade.You will post your initial response to the prompt by Fridays at 11:59pm and respond to two classmates by Sunday at 11:59pm of the week they are listed.

Capstone Project: There will be a single capstone project that you will work on continuously throughout the semester. You will have opportunities to iterate and revise your work based on instructor feedback in the form of **Weekly Project Deliverables** (**30%** of the

final course grade) and culminating in the **Capstone Project Report** itself (**15%** of your final course grade).

The project will require conducting original research with engineering data visualization and data modeling to predict the behavior of systems using large data sets. A potential list of databases from which to extract data will be provided, but you are encouraged to search for your own as well. If you have difficulty finding a useful data set, the instructor can provide additional guidance. The project is an individual project. Code or other digital tools used to generate figures and results for the report should be submitted as an Appendix to the report. More detail will be given later about the contents and layout of these reports.

There will also be two **Project Update Presentations** throughout the course (**10%** of your final course grade), to present your progress towards the capstone project. Given the online nature of the course, you are expected to use slide software such as MS PowerPoint or Google Slides in conjunction with WebEx or Kaltura to record a voiceover of your presentation. Details of the contents of these presentations will be provided later.

Feedback

I will deliver feedback on each assignment using the comments feature in Canvas.

Exam Information and Policies

This course does not have any exams. Per the NJIT Online Course Exam Proctoring Policy, this course will use authentic assessment, meaning you will be assessed and graded on your ability to deliver real-world outputs as well as your participation and feedback to other students.

Policy for Late Work

All assignments must be submitted in a timely manner and by the due date. Late work will be accepted up to 24 hours after the due date with no penalty. Assignments submitted in excess of 24 hours late will receive a reduction of 50% of the assignment's total point value each successive day they are late (i.e. 50% at 48 hours, 100% at 72 hours). Please note, if you miss an assignment for a legitimate medical reason or other emergency, this must be documented with the Dean of Students (dos@njit.edu). Once documented, you will be excused from the missed assignment (it will have no weight on your grade). Please be proactive in communicating such situations with your instructor.

Academic Integrity

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the NJIT academic code of integrity

policy.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"

Netiquette

Throughout this course, you are expected to be courteous and respectful to classmates by being polite, active participants. You should respond to discussion forum assignments in a timely manner so that your classmates have adequate time to respond to your posts. Please respect opinions, even those that differ from your own, and avoid using profanity or offensive language. Violations of the NJIT code of student conduct will be reported to the Dean of Students, and could result in ejection from the course.

Weekly Expectations

This course is organized by weekly modules. Each week, students must watch the lecture videos, complete any associated reading and homework assignments, and participate in the class discussion forum by Friday at 11:59pm (**Note: responses to classmates are due by Sunday at 11:59PM)**

Course Schedule

Week	Topic	Learning Activities	Due Dates
1	What is Visual Communication?	Module 1 Discussion: Prior Experiences with Visual Communication Capstone Project (CP) Assigned	1/19
2	Aesthetics and Principles of Visual Design	Who cares if my data is pretty? Module 2 Discussion: Aesthetics of Your Prior Work Module 2 Assignment: Aesthetics and Principles of Visual Design Capstone Project Deliverable 1: Topic Exploration	1/26

3	The Visual Design Process & Editorial Thinking	Module 3 Discussion: Are You a Good Infographic, or a Bad Infographic? Module 3 Assignment: Editing for Angle, Clarity, and Focus Capstone Project Deliverable 2: Narrowing Down Your Project Topic	2/2
4	Universal Design	Module 4 Discussion: Let's Get Critical - UD Journal Article Critique Module 4 Assignment: Editing for Accessibility Capstone Project Deliverable 3: Annotated Bibliography	2/9
5	Written and Oral Presentation of Data	Module 5 Discussion: Literature Review Q&A Module 5 Assignment: PowerPoint Presentation Draft of Literature Review Capstone Project Deliverable 4: Draft Paper Introduction & Literature Review	2/16
6	Techniques for Time-Oriented Engineering Data	Module 6 Discussion: Talk to Me: Peer Feedback on Oral Presentation Drafts Module 6 Assignment: Time is a Flat Circle Capstone Project Deliverable 5: Formulating Your Research Questions	2/23

7	Techniques for Spatial Engineering Data	Module 7 Discussion: Decisions, Decisions! Module 7A Assignment: Let the Fluid Flow (Macro) or: Module 7B Assignment: Fill 'Er Up! (Micro) Capstone Project Deliverable 6: Exploring Your Database Mid-Semester Check-In	3/1
8	Project Update 1	Project Update 1 Capstone Project Deliverable 7: Data Collection Progress Report	3/8
Spring Break - Week of 3/11-15			
9	Review of statistical modeling techniques	MATLAB Skill Check Module 9 Discussion: Let's Get Critical (and Statistical!) Module 9 Assignment: Can you show me the stats on that? Capstone Project Deliverable 8: Gathering Your Data	3/22
10	Techniques for Multivariate Engineering Data & Data transformation (PCA)	Module 10 Discussion: Let's Get Critical (and Statistical!) Part 2 Module 10 Assignment: My First PCA Capstone Project Deliverable 9: Planning Your Analysis	3/29
11	Addressing and mitigating bias in statistical models	Module 11 Discussion: Bias in Chemical Engineering Research	4/5

		Module 11 Assignment: Hey, That's Biased! Capstone Project Deliverable 10: Performing Your Analysis	
12	Root-Cause Analysis (RCA)	Module 12 Discussion: Another Application of Root Cause Analysis Module 12 Assignment: Needle in a Haystack Capstone Project Deliverable 11: Training Your Model	4/12
13	Techniques for Trees, Graphs and Networks	Module 13 Discussion: It’s Been There All Along: Chemical Graph Theory Module 13 Assignment: Can’t See the Forest through the Tree Graphs Capstone Project Deliverable 12: Making Predictions: Testing Your Model	4/19
14	Comparing and Evaluating Data Visualization Methods	Module 14 Discussion: Let's Get Critical and Experimental Module 14 Assignment: Getting Experimental Capstone Project Deliverable 13: Answering Your Research Questions	4/26
15	Project Update 2	Project Update 2 Capstone Project Deliverable 14: Next Steps	5/3
16	Capstone Report Due	Capstone Report	5/8

Additional Information and Resources

Accessibility:

This course is offered through an accessible learning management system. For more information, please refer to Canvas's Accessibility Statement.

Requesting Accommodations:

The Office of Accessibility Resources and Services works in partnership with administrators, faculty, and staff to provide reasonable accommodations and support services for students with disabilities who have provided their office with medical documentation to receive services.

If you are in need of accommodations due to a disability, please contact the Office of Accessibility Resources and Services to discuss your specific needs.

Resources for NJIT Online Students

NJIT is committed to student excellence. To ensure your success in this course and your program, the university offers a range of academic support centers and services. To learn more, please review these Resources for NJIT Online Students, which include information related to technical support.