Syllabus

This is a single, concatenated file, suitable for printing or saving as a PDF for offline viewing. Please note that some animations or images may not work.

Description

This module is also available as a concatenated page, suitable for printing or saving as a PDF for offline viewing.

MET CS 566

Analysis of Algorithms

This course teaches theoretical backgrounds for design and analyzing algorithms, as well as practical implementation methods. The course starts with a review of principles of algorithm analysis and includes divide and conquer, dynamic programming, greedy programming, matrix operations, and extend them to advance topics of linear programming. Students should be familiar with basic data structures and basic Python programming. Weekly course assignments include both theoretical analysis and practical algorithmic implementation in python.

Prerequisite: MET CS 521 (Information Structures with Python) and MET CS 526 (Data Structures and Algorithms), or instructor's consent

Technical Notes

The table of contents expands and contracts (+/- sign) and may conceal some pages. To avoid missing content pages, you are advised to use the next/previous page icons in the top right corner of the learning modules.

This course requires you to access files such as word documents, PDFs, and/or media files. These files may open in your browser or be downloaded as files, depending on the settings of your browser.

Learning Objectives

By successfully completing this course, you will be able to:

- Implement algorithm with the theoretical backgrounds of computer science analysis and design, as well as practical implementation methods.
- Understand the concepts of asymptotic notation in the analysis of algorithms and its usage in comparing algorithm performance.
- Understand the concepts of divide and conquer algorithms and its usage in algorithm design.
- Understand the concepts of hashing, binary search trees, graph algorithms, and dynamic programming.
- Describe advanced analysis of algorithm topics like NP-Completeness and NP-Hard problems.

Instructor

Eric Braude, Ph.D.

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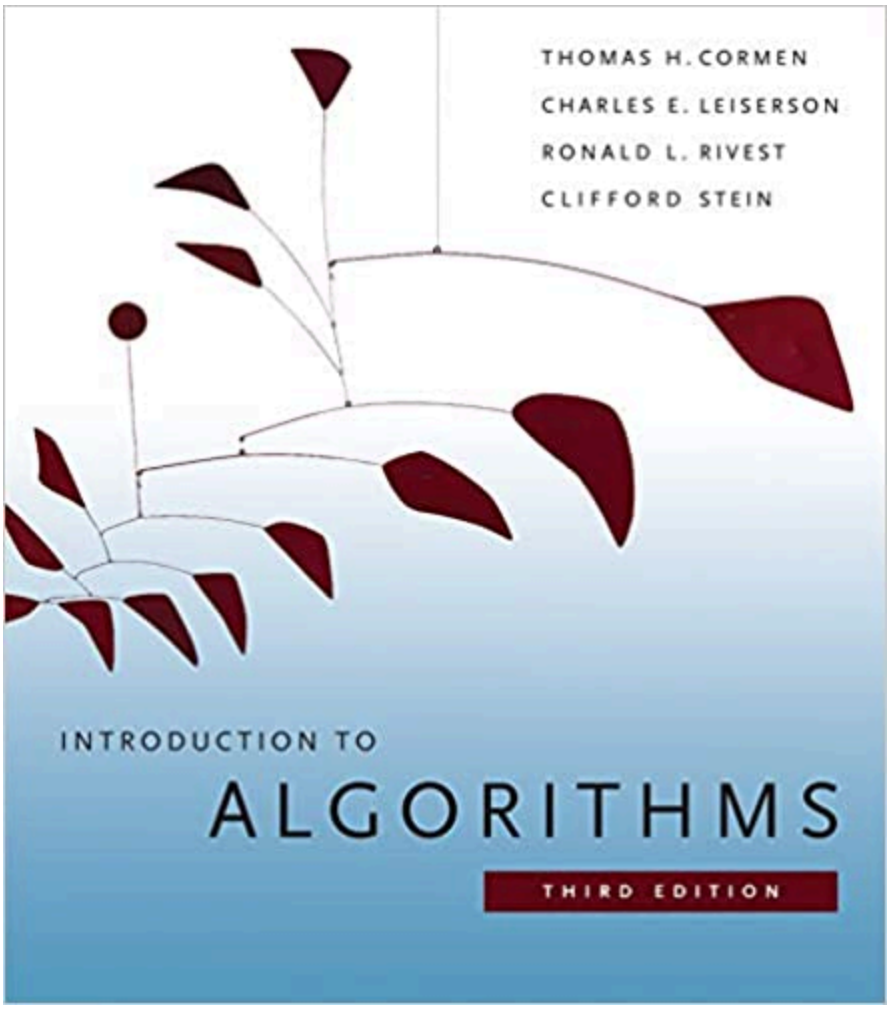
Eric received his Ph.D. in mathematics from Columbia University and master's degree in computer science from the University of Miami. He taught at CUNY and Penn State, followed by 12 years in government and industry as a software engineer, scientist, and manager. He is an associate professor of computer science at Boston University's Metropolitan College, where he has at times held the chairmanship and the acting associate deanship. His research concerns program construction and machine learning. Eric has written, cowritten, or edited six books, including *Software Engineering* and *Software Design*. His background in AI goes back to 1980, when he established one of the first industry AI labs at one of the largest US corporations. Eric has taught AI at BU, Penn State, and the University of Pennsylvania. His current research includes the application of fuzzy methods to machine learning, UML for development at scale, and methods for accelerating machine learning. His newest book "Algorithms and Programs" is close to completion.

Read Professor Braude's complete resume.

Materials

Required Book



Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2022). *Introduction to Algorithms*. 4th ed. The MIT Press.

ISBN: 978-0262046305.

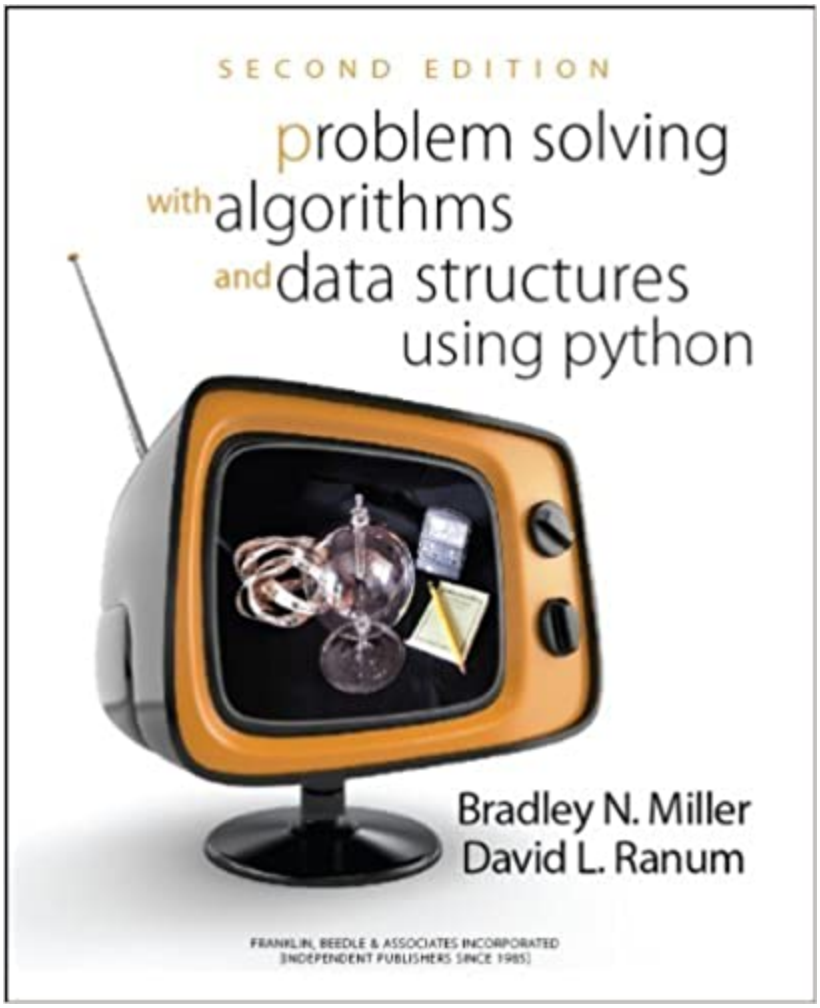
This book can be purchased from Barnes and Noble at Boston University. An e-book is available from the MIT Press.

Notes:

- We refer to the book as CLRS book in the course.
- The 3rd edition of the text is also acceptable for the course. “The 4th edition and the 3rd edition have the same content. The only structural change is that the 4th edition moves section 14 ‘Augmenting Data Structures’ to section 17. The following section # (14~24) may have 1~2 misalignments with the 3rd edition.”

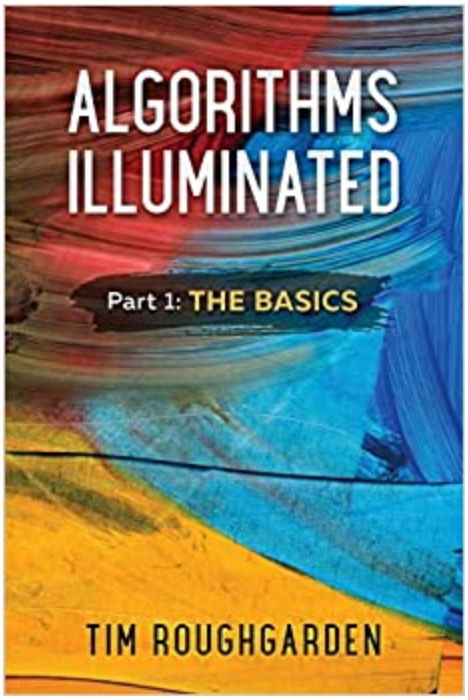
Recommended Books

There will be no reading assignments from the recommended books.



Miller, B., & Ranum, D. (2011). *Problem Solving with Algorithms and Data Structures Using Python*. 2nd ed.
Franklin, Beedle & Associates.

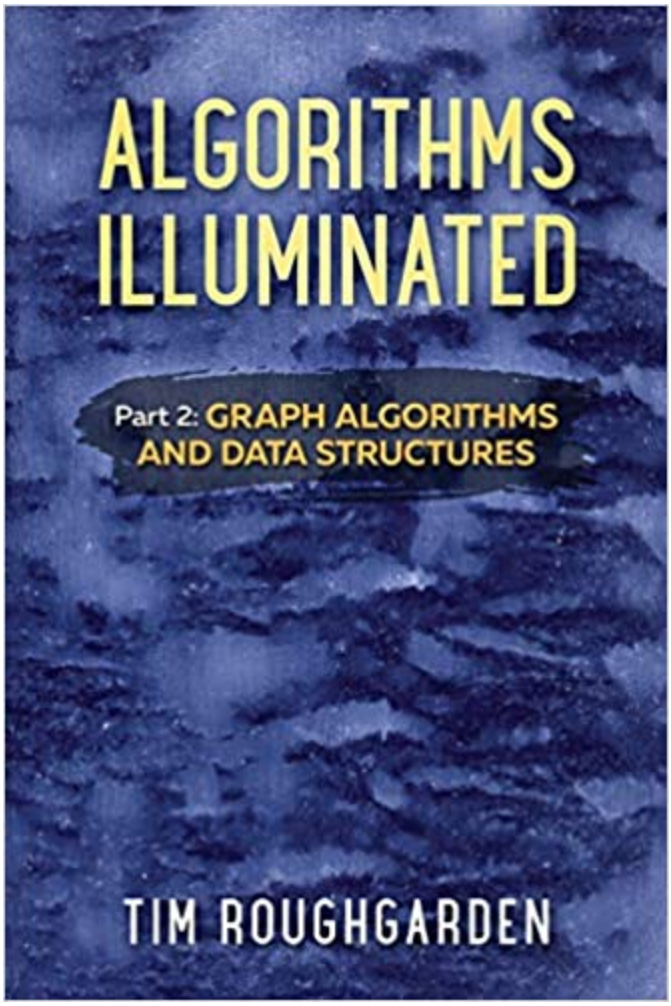
ISBN: 978-1590282571.



Roughgarden, T. (2017). *Algorithms Illuminated (Part 1): The Basics*.
Soundlikeyourself Publishing.

ISBN: 978-0999282908.

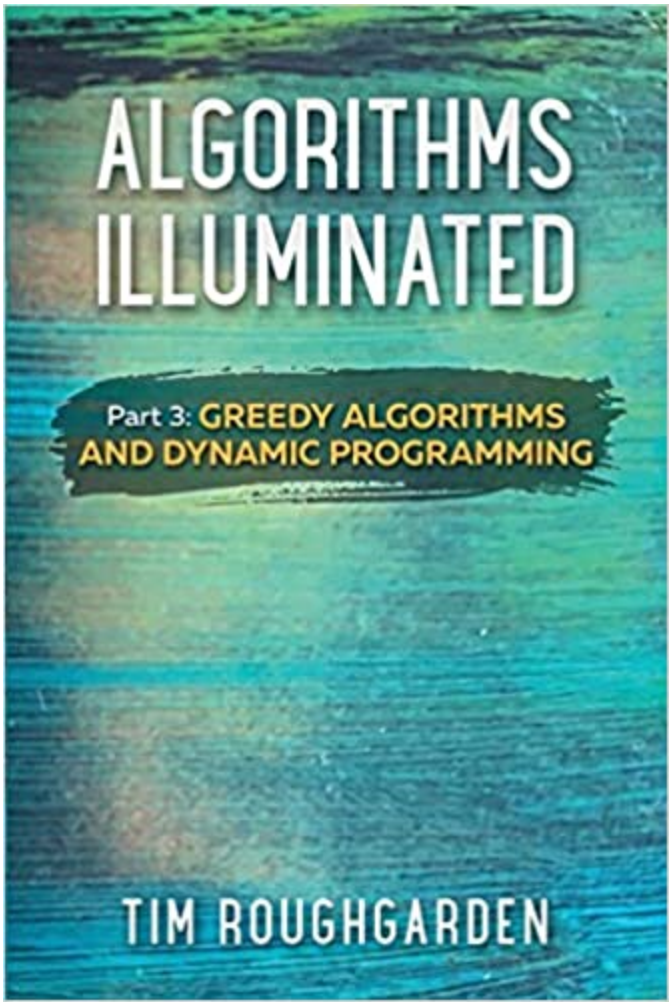
Roughgarden, T. (2018). *Algorithms Illuminated (Part 2): Graph Algorithms and Data Structures*.
Soundlikeyourself Publishing.



ISBN: 978-0999282922.

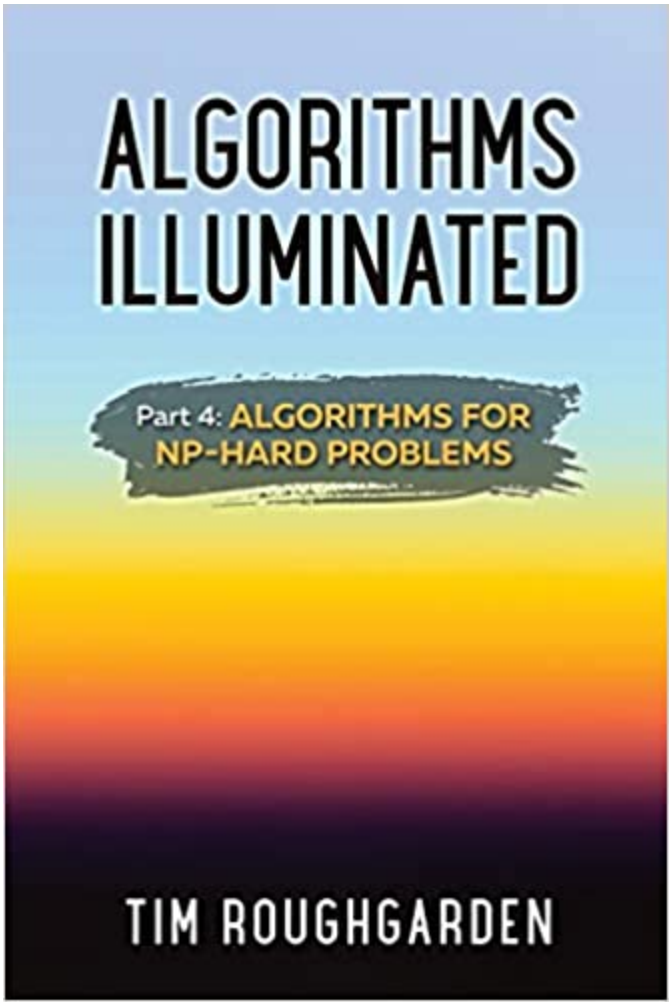
Roughgarden, T. (2019). *Algorithms Illuminated (Part 3): Greedy Algorithms and Dynamic Programming*. Soundlikeyourself Publishing.

ISBN: 978-0999282946.



Roughgarden, T. (2020). *Algorithms Illuminated (Part 4): Algorithms for NP-Hard Problems*. Soundlikeyourself Publishing.

ISBN: 978-0999282960.



Boston University Library Information

Boston University has created a set of videos to help orient you to the online resources at your disposal. An introduction to the series is below:

met_ode_library_14_sp1_00_intro video cannot be displayed here. Videos cannot be played from Printable Lectures. Please view media in the module.

All of the videos in the series are available on the Online Library Resources page, which is also accessible from the Campus Bookmarks section of your Online Campus Dashboard. Please feel free to make use of them.

As Boston University students, you have full access to the BU Library. From any computer, you can gain access to anything at the library that is electronically formatted. To connect to the library, use the link http://www.bu.edu/library. You may use the library's content whether you are connected through your online course or not, by confirming your status as a BU community member using your Kerberos password.

Once in the library system, you can use the links under “Resources” and “Collections” to find databases, eJournals, and eBooks, as well as search the library by subject. Some other useful links follow:

Go to Collections to access eBooks and eJournals directly.

If you have questions about library resources, go to Ask a Librarian to email the library or use the live-chat feature.

To locate course eReserves, go to Reserves.

Please note that you are not to post attachments of the required or other readings in the water cooler or other areas of the course, as it is an infringement on copyright laws and department policy. All students have access to the library system and will need to develop research skills that include how to find articles through library systems and databases.

Free Tutoring Service

Free online tutoring services by Tutor.com are available to BU online students for the duration of their eligible online course. Tutor.com is a web-based service that provides an online writing lab and access to on-demand and scheduled tutoring sessions for writing, math, business, coding languages, and other subjects. Students can submit a question to a tutor, submit a paper for feedback about writing and grammar, or schedule a live session with a tutor.

You can log in directly to Tutor.com from Blackboard Online Campus by clicking the link in the left-hand navigation menu within your online course. All activity in the Tutor.com classroom is recorded for learner review and quality control. Transcripts will be available afterward in My Account under My Locker in your Tutor.com account.

Please Note

Tutor.com services may be used only for current Boston University online courses and career services. Use of this service for purposes other than current coursework or career services may result in deactivation of your Tutor.com account.

Study Guide

Module 1 Study Guide and Deliverables

Theme: Principles of Algorithm Analysis

Topics:
- Specifying Functions and Classes
- Algorithm Foundations and Complexity
- Algorithm Creation and Analysis
- A Generic Problem Formulation

Readings:
1. Blackboard module notes
2. CLRS (Cormen et al) I 1-3, primarily understand the meaning of O(n). We'll return later to math reasoning like that on pp. 30-43.

Assignments:
- Self-Introduction due Thursday, January 16, at 11:59 PM ET (not graded; access at "Class Discussion" on the left-hand course menu)
- Draft Assignment 1 due **Sunday, January 19, at 6:00 AM ET** (access at "Assignments" on the left-hand course menu)
- Assignment 1, due **Wednesday, January 22, at 6:00 AM ET** (access at "Assignments" on the left-hand course menu)

Live Classroom:
- Wednesday, January 15, from 8:00 PM to 9:00 PM ET
- Thursday, January 16, from 8:00 PM to 9:00 PM ET
- Live Office: Wednesday and Thursday after Live Classroom, for as long as there are questions

Module 2 Study Guide and Deliverables

Theme: Divide and Conquer

Topics:
- Divide-and-Conquer Definition
- Example Applications

- Complexity of Binary Search
- False “Divide and Conquer”
- Maximum Sub-Array Example

Readings:

1. Blackboard module notes
2. CLRS: Primarily pp. 34-35. Most of the references in the index to divide-and-conquer use a formulaic approach to efficiency calculations. We will not emphasize formulas.

Assignments:

- Draft Assignment 2 due **Sunday, January 26, at 6:00 AM ET** (access at "Assignments" on the left-hand course menu)
- Assignment 2, due **Wednesday, January 29, at 6:00 AM ET** (access at "Assignments" on the left-hand course menu)

Live Classroom:

- Wednesday, January 22, from 8:00 PM to 10:00 PM ET
- No live session on Thursday this week
- Live Office: after Live Classroom, for as long as there are questions

Module 3 Study Guide and Deliverables

Theme: Sorting

Topics:

- The Sorting Algorithm Outline
- Mergesort
- Quicksort
- Heapsort
- Radix Sort
- Example of Custom Algorithm

Readings:

1. Blackboard module notes
2. CLRS: Primarily pp. 157-226. These contain figures illustrating the progress of various sorts.

Assignments:

- Draft Assignment 3 due **Sunday, February 2, at 6:00 AM ET**
- Assignment 3, due **Wednesday, February 5, at 6:00 AM ET**

Live Classrooms:

- Wednesday, January 29, from 8:00 PM to 10:00 PM ET
- No live session on Thursday this week

- Live Office: after Live Classroom, for as long as there are questions

Module 4 Study Guide and Deliverables

Theme: Dynamic Programming

Topics:
- Definition
- Longest Common Subsequence

Readings:
1. Blackboard module notes
2. CLRS: pp. 362-372, 382-3, and 392-398

Assignments:
- Draft Assignment 4 due **Sunday, February 9, at 6:00 AM ET**
- Assignment 4, due **Wednesday, February 12, at 6:00 AM ET**

Live Classroom:
- Wednesday, February 5, from 8:00 PM to 9:00 PM ET
- Thursday, February 6, from 8:00 PM to 9:00 PM ET
- Live Office: Wednesday and Thursday after Live Classroom, for as long as there are questions

Module 5 Study Guide and Deliverables

Theme: Greedy Algorithms

Topics:
- The Greedy Algorithm
- Room Scheduling Example Completed
- Huffman Codes
- Time Complexity of Greedy Algorithms

Readings:
1. Blackboard module notes
2. CLRS: pp. 417, 426-435

Assignments:
- Draft Assignment 5 due **Sunday, February 16, at 6:00 AM ET**
- Assignment 5, due **Wednesday, February 19, at 6:00 AM ET**

Live Classroom:	• Wednesday, February 12, from 8:00 PM to 9:00 PM ET • Thursday, February 13, from 8:00 PM to 9:00 PM ET • Live Office: Wednesday and Thursday after Live Classroom, for as long as there are questions

Module 6 Study Guide and Deliverables

Theme:	Graphs Algorithms
Topics:	• Minimum Spanning Trees • Shortest Paths
Readings:	1. Blackboard module notes 2. CLRS Sections 20.1, 21.1, 21.2, 22.1 and 22.3
Assignments:	• Draft Assignment 6 due **Sunday, February 23, at 6:00 AM ET** • Assignment 6, due **Wednesday, February 26, at 6:00 AM ET**
Live Classroom:	• Wednesday, February 19, from 8:00 PM to 9:00 PM ET • Thursday, February 20, from 8:00 PM to 9:00 PM ET • Live Office: Wednesday and Thursday after Live Classroom, for as long as there are questions
Course Evaluation:	Please complete the course evaluation once you receive an email or Blackboard notification indicating the evaluation is open. Your feedback is important to MET, as it helps us make improvements to the program and the course for future students.

Final Exam Details

The Final Exam is a proctored exam available from **Wednesday, February 26 at 6:00 AM ET to Saturday, March 1 at 11:59 PM ET**.

The Computer Science department requires that all final exams be administered using an online proctoring service, which you will access via your course in Blackboard. In order to take the exam, you are required to have a working computer, webcam, speakers, and microphone that meet the proctoring service's system requirements. A detailed list of those requirements can be found in the Proctored Exam Information module located on the course home page. Additional information regarding your proctored exam will be

forthcoming from the Assessment Administrator. You will be responsible for scheduling your proctored exam session within the defined exam window.

The Final Exam is accessible only during the final exam period. You can access it from the “Assessments” section of the course. Your proctor will enter the password to start the exam.

Final Exam Duration: three hours.

Evaluation of Students and Grading

To attain excellence ("A" work), you are expected to go beyond satisfying the assignment statement essentials, and to develop your own analyses and comparisons. Additional detailed criteria are listed later in this Syllabus section.

To help the teaching team clarify points in students’ work, grades are subject to students possibly being required to answer questions orally about the work they have submitted. Reasonable notice will be given.

Basis for Grades

There are three components to your grades.

1. **Draft Assignments**
    - Each Draft Assignment typically requests part of the module's assignment and is intended to help you complete the latter. You may only submit your draft assignment once, so that you can get feedback before your assignment for that module is due. We encourage you to start the draft version early in each module.
    - Draft Assignments are graded on a Pass/Fail basis, with Pass=1, Fail (Not yet acceptably on track)=0, and Neither=0.5.
    - Draft Assignment 6 in Module 6 is optional, so you can concentrate on completing your Assignment 6 during Week 6. Your draft assignments grade will be calculated from Draft Assignment 1 to Draft Assignment 5. If you do choose to complete Draft Assignment 6, its grade will replace a prior draft assignment with a 0.5 or 0.0 grade—if one exists. (There is no extra credit for Draft Assignment 6 other than this.)
    - Access and submit the Draft Assignments in the "Assignments" area.

2. **Assignments**
    - The purpose of weekly assignment is to give you hands-on practice with what you have learned.
    - You are permitted to submit and resubmit your weekly assignment unlimited times to improve your work, provided you do so before the assignment deadline for that module. Only the last on-time version will be graded.
    - The weekly assignments in total are worth 60% of the course grade. The teaching team expects your understanding to improve throughout the course. Accordingly, the first sets of assignments weigh less than the rest, so you will have opportunities to catch up along the way. The weight of assignments ramps up as follows:
        - Assignment 1 (Module 1): 7%
        - Assignment 2 (Module 2): 7%
        - Assignment 3 (Module 3): 9%
        - Assignment 4 (Module 4): 11%
        - Assignment 5 (Module 5): 13%
        - Assignment 6 (Module 6): 13%
    - Access and upload the assignment in the "Assignments" area.
3. **Final Exam**
    - There will be a proctored final exam in this course. Detailed instructions regarding your proctored exam will be forthcoming from the Assessment Administrator. You will be responsible for scheduling your own appointment.
    - The grading criteria for each question are shown in the Final Exam Essay Questions Rubric below. You must provide explanation of all of your answers, and it will be subject to these criteria. The exam has occasional reminders to explain your answers.
    - Please keep the contents of the final exam confidential. Sharing details about this exam constitutes academic misconduct for both parties.
    - Access and submit the final exam in the "Assessments" area.

Grade Computations

The course grade will be computed from the following:

Overall Grading Percentages	
Draft Assignments	10
Assignments	60
Proctored Final Exam	30

Rubrics

Assignments Rubric
The term project assignments are graded according to the rubric below. These are averaged using the following guidelines: A+ = 97, A = 95, A- = 90, B+ = 87, B = 85, B- = 80 etc. When a paper is considered outstanding, a score of up to 100 can be given.

The assignment rubrics will look approximately like the following.

Criteria	D	C	B	A
Correctness	No justification of correctness	Tests, comments, and explanations mostly correct	Tests, comments, and explanations justify correctness; honored all instructions	Tests, comments, and explanations justify correctness extremely well; complete and thorough; honored all instructions
Clarity	Unclear	Explained; somewhat clear	Every class, class relationship, and method clearly specified; well commented; clear; little redundant code	Every class, class relationship, and method precisely specified; thoroughly commented; entirely clear; negligible redundant code
Understanding	Minor understanding evidenced	Satisfactory understanding evidenced	Evidence of good understanding throughout	Evidence throughout of entirely thorough understanding

Draft Assignment Rubric
The draft assignment grades are: *Pass (Acceptably on track)* (1), *Fail (Not yet acceptably on track)* (0), and *Neither* (0.5).

Final Exam Essay Questions Rubric
Please respond to the following question as concretely and as clearly as you can, citing specifics from your term project (i.e., avoid generalities—statements that apply to most projects of your overall type).

To demonstrate your understanding, use your own words. Where you have no clear conclusions, describe the relevant trade-offs. Each question will be evaluated using rubrics like the following.

The resulting grade is the average of these, using: A+ = 97, A = 95, A- = 90, B+ = 87, B = 85, B- = 80 etc.

Criteria	D	C	B	A
Technical Correctness	No justification of correctness	Technically mostly correct	Implementation correctness well justified; commented completely; well commented and tested	Implementation correctness thoroughly justified throughout by precise block- and line-comments and tests
Clarity in Presentation	Unclear	Somewhat clear	Clear with a few exceptions	Entirely clear throughout
Depth and Thoroughness of Coverage	Shallow or superficial coverage of most topics	Satisfactory depth and thoroughness	Evidence of depth and thoroughness in covering most topics	Evidence of depth and thoroughness in covering all topics

To get an A grade for the course, your weighted average should be >=93; for A-, >=90; B+, >=87; B, >=83; B-, >=80; etc.

By the time grades are submitted to the registrar, the class average will be approximately an 87 (B+).

Grades typically start lower, allowing room for growth as the term progresses.

> An A grade at Boston University is reserved for excellent work. If you are given and A, you are to be congratulated. The university officially designates good work as deserving of a B and we reward good work with a B accordingly. It is our obligation to tell you, as far as we can, what would improve your work. (That can sometimes be hard if you receive an A, of course.) If you don't see such feedback, please remind your facilitatorinstructor about it. Grades are an excellent motivator, but they are only means to an end rather than ends in themselves. The average grade in graduate courses is usually expected to be a B+. If the course average turns out to be less than this at the end of the

term, and the class performance is not less than average, I am able to elevate some grades that fall on borderlines.

Ungraded Items:

- **Ungraded Discussion Forums:** There are ungraded discussion forums throughout the course. You are encouraged to share your knowledge and learn from your peers. Discussion forums are provided for your benefit. Some discussion forums involve the instructional staff; others are among students.
- **Live Classroom Sessions:** Live Classroom sessions will be offered during this course in Modules 1 through 6. In each module, students have a Live Classroom session with the instructor and another Live Classroom (or problem-solving session) with the facilitator. Days/times will be posted in the Study Guide and the "Announcements" area.
    - Your participation, while not mandatory, will be valuable to you and the class. To participate in the Live Classroom discussion, you will need to go to the "Live Classroom/Offices" area.
    - Live Classroom sessions will be recorded and archived for further viewing. You can go to the "Live Classroom Recordings" area to view the recordings.

Expectations

We recognize that emergencies occur in professional and personal lives. If one occurs that prevents your completion of homework by a deadline, please make this plan to your facilitator. This must be done in advance of the deadline (unless the emergency makes this impossible, of course), and should be accompanied by particulars that back it up. Additional documentation may be requested. **No regular credit will otherwise be granted for late homework, but we will note it and it may influence your course grade at the end of the term.**

Boston University Metropolitan College