A (possibly updated) copy of this document is available online at: https://euclid.cs.qc.cuny.edu/316

Spring 2022

CSCI 316: Principles of Programming Languages (M W 1:40, 5:00, and 8:00 pm Sections)

Lectures will be given in the classroom / lecture hall.
Some lectures will also be live-streamed on Blackboard Collaborate Ultra.

Instructor Dr. T. Yung Kong (tkong@qc.cuny.edu) Voicemail: 718-425-9934

Office Hours M W 6:40 – 7:15 and 9:35 – 10:00 pm on Zoom: Click on Virtual Office Hours on the left side of your class's Blackboard page for more information.

Students will complete an implementation of a small programming language ("TinyJ") that is a subset of Java. This major programming project will involve reading and understanding code that is already written as well as writing code. It is to be done in Java, which students are assumed to have learned in an earlier course.

The project will provide a basis for concrete discussions of many aspects of programming languages—e.g., expressions and their evaluation, structured statements and their execution, arrays and pointers, storage allocation (static, stack-dynamic, and heap-dynamic) for variables, function call and return, parameter passing, scope, virtual machines.

In addition, this course will acquaint students with the *functional* programming paradigm (as an alternative to the procedural and object-oriented imperative paradigms that students will be familiar with from earlier courses). Students will learn to program in a functional style in the language Lisp.

Other topics relating to programming languages (e.g., programming language syntax) will also be covered, in class and/or by reading assignments.

Learning Goals

- To understand a variety of fundamental concepts relating to the design, specification, and implementation of programming languages.
- To become acquainted with the functional programming paradigm and the use of the programming language Lisp to solve problems in a functional style with frequent use of recursion.

Required Course Reader and Required Textbook

1. Course reader sold by the Queens College Online Bookstore (https://qc.textbookx.com); this contains selections from: R. Sethi, *Programming Languages*, 2nd ed., Addison-Wesley, 1996.[1]
   IMPORTANT: Certain exam questions may assume you have a copy of this course reader that you can refer to during the exam. *A copy of the course reader may be used during exams if it is a legal copy, its pages have no notes or markings, and nothing else is enclosed within its pages. The exams will otherwise be closed book.*
2. D. S. Touretzky, *Common Lisp: A Gentle Introduction to Symbolic Computation*, Dover, 2013. ISBN 978-0486498201.[2]

Some Recommended Textbooks

3. M. L. Scott, *Programming Language Pragmatics*, 4th ed., Morgan Kaufman, 2016.[3]
4. P. Seibel, *Practical Common Lisp*, Apress, 2012.[1,4] https://dl.acm.org/doi/book/10.5555/2339396
5. R. Wilensky, *Common LISPcraft*, Norton, 1986.[1]
6. P. Winston and B. Horn, *Lisp*, 3rd ed., Addison-Wesley, 1989 (reprinted with corrections, 1997).[1]

[1] This book is on reserve in the Library: See https://qc-cuny.libguides.com/er.php?course_id=18376.

[2] An electronic version of this book is available online (to Queens College students) through the Library—see https://ebookcentral.proquest.com/lib/qc-ebooks/detail.action?pq-origsite=primo&docID=1920062, and almost all of the content of an older edition of the book is publicly available online—see https://www.cs.cmu.edu/~dst/LispBook/book.pdf.

[3] An older edition of this book is available online (to Queens College students) through the Library—see https://ebookcentral.proquest.com/lib/qc-ebooks/detail.action?pq-origsite=primo&docID=649018.

[4] The text of this book is available online—see https://www.gigamonkeys.com/book/.

Grading Policy

Grades will be a measure of attainment (not effort). Your grade will be based on your scores on the cumulative Final Exam, two other exams, and six for-credit programming assignments[5] (the last three of which will constitute the above-mentioned TinyJ implementation project). ***Some exam questions will relate to programming assignments.*** The maximum possible scores on the exams and assignments will be as follows:

Exam 1:	25 points
Exam 2:	25 points
Cumulative Final Exam:	40 points
For-Credit Lisp Assignments:	0.5 + 2.0 + 2.0 = 4.5 points
TinyJ Implementation Assignments:	1.5 + 2.0 + 2.0 = 5.5 points

When I consider your scores for grading purposes, **I will first replace the *lower* of the scores on Exam 1 and Exam 2 with (Final Exam score × 25/40) if the latter is higher.** (If your scores on Exams 1 and 2 are equal, at most one of those scores will be replaced in this way.) Bearing this in mind, let:

a = sum of your exam scores and scores on for-credit assignments
b = (sum of your exam scores) × 100/90

Your grade will be computed from the values of a and b using rules A and B below—if the rules give different grades, you will receive the higher of those two grades. (Note that ***no grades of*** C− ***will be given***.)

Rule A I will consider you to be an ***A-range student*** if the following are ***both*** true:

1. $a \geq 87$
2. You have a higher Final Exam score than at least 70% of the students in the class.

If $a \geq 97$ and you have a higher Final Exam score than at least 90% of the students in the class, then your grade for the course will be A+.

If you are an A-range student and the previous sentence does not apply to you, then your grade will be A− or A according to whether $a < 90$ or $a \geq 90$.

If you are not an A-range student, then your grade will be F if either of the following is true:

(i) You are a graduate student, or are an undergraduate who *has asked to be excluded* from consideration for D+ and D grades,[6] and a is less than the threshold score for C.

(ii) You are an undergraduate who *has not asked to be excluded* from consideration for D+ and D grades,[6] and a is less than the threshold score for D.

If you are not an A-range student and neither (i) nor (ii) applies to you, then you will receive the highest grade below A− for which a is greater than or equal to that grade's threshold score. Provisional threshold scores for grades below A− are as follows: B+ 83, B 80, B− 76, C+ 73, C 69, and, for undergraduates who are being considered[6] for D+ and D grades, D+ 63, D 60. The threshold score for C may be lowered by up to 1 point for some students, at the instructor's discretion.

Rule B No grades of A+ will be awarded on the basis of this rule. Otherwise, rule B is the same as rule A except that b is used in place of a, threshold scores for grades might be a little lower, and the definition of "A-range student" might be a little broader.

There will be no make-ups for Exams 1 and 2: Missing either exam will be equivalent to scoring 0 on that exam, but the 0 will be replaced by* (your Final Exam score × 25/40) *if you miss just one exam.

Students who are absent from Exam 2 and the Final Exam may possibly be given a WU.

Assignments and Late Submission Policy

You may work either on your own or with up to two other students on the for-credit assignments. ***However, when two or three students work together on an assignment each student must write up his/her own submission (which needs to clearly state the name(s) of his/her partner(s)) independently, and is expected to fully understand all parts of the submission. No two students may make submissions that are essentially the same.***

[5] Although the for-credit programming assignments will not count more than 10% towards your grade, and other homework exercises will not carry any credit, you should not underestimate the importance of doing this work. When you are given any homework (e.g., a reading assignment), assume that the work is to be done before the next exam unless some other deadline is explicitly indicated. Exam questions that are similar or related to for-credit and not-for-credit assignments or other homework exercises will count ***at least 35%*** towards your grade.

[6] Undergraduates in this course will be asked in May to say whether they wish to be considered for D+ and D grades in the event that they do not qualify for a course grade of C or better.

For-credit programming assignments are to be submitted by leaving your source file(s) in the appropriate directory on the machine `euclid.cs.qc.cuny.edu`. You will be given a `euclid` account for that purpose—see page 6 of this document. ***Attempted "submissions" that are not made on euclid—e.g., "submissions" by e-mail—will not be graded!*** As explained on p. 5 of this document, you also have an account on another machine, `venus` / `mars`. You can do assignments on `euclid` or on `venus` / `mars` or on your own PC, but assignment submissions must be left on `euclid` (***not*** `venus` / `mars`)!

You can do assignments on your Windows PC if you can install GNU Clisp (see the "Lisp Assignment 1" document for instructions) and have installed or can install the Java JDK. The latter is available at the following URL: https://www.oracle.com/java/technologies/downloads/. After installing the JDK, update the PATH environment variable to include the directory that contains the compiler `javac.exe` and the program `jar.exe` that are part of the JDK you installed.[7] Students who cannot get Clisp or the JDK to work on their PCs may have to do assignments on `euclid` or `venus` / `mars`.

If you do assignments on `venus` or your own PC then, when you are ready to submit, you can use an scp or sftp client to put a copy of the `.lsp` or `.java` file(s) you are submitting in the right directory on `euclid`.[8] ***You must keep a backup copy of each submitted file on*** `venus` / `mars`, ***and another elsewhere***.

Here are ***tentative approximate***[9] due dates of the for-credit assignments:

Lisp Assignment 3:	Early to mid-March
Lisp Assignment 4:	Mid- to late March
Lisp Assignment 5:	Late March.
TinyJ Assignment 1:	Late April or early May
TinyJ Assignment 2:	Early to mid-May
TinyJ Assignment 3:	After the last class

Late / corrected submissions of any assignment may be made until a late-submission deadline that will be announced later, but may incur a penalty as explained below. Assignments will not be graded before their late-submission deadlines. Different assignments may have different late-submission deadlines, but no late-submission deadline will be earlier than Exam 1.

If when I compute a student's course grade I see that the number of assignments submitted late (as defined in the next paragraph) is ≥ 4, the student is subject to a penalty of $N - 3$ points, where N is the number of assignments submitted late. There is no penalty if $N < 4$.

If you are unsure whether one of your assignment submissions is on-time or late, you can find out using the command `ls -lc` *name* (e.g., `ls -lc doe-3.lsp` or `ls -lc TJ1asn/Parser.java`): Entering this command on `euclid` will show the "last change time" of the file whose pathname is ***name***. For grading purposes, "number of assignments submitted late" means the number of different assignments for which the last change time of a submitted file (as shown by the command `ls -lc` *name* on `euclid`) is after the assignment's due date.

Academic Misconduct. Plagiarism

Students found to have provided their answers to others during an exam or to have submitted work of others as their own will receive a grade of F for the course.

Attendance

Students are expected to attend all classes. Students who are absent from part or all of a class are responsible for catching up and *must not assume that I will assist them in doing that.*

E-mail Forwarding

I will send important e-mail to your `euclid` account from time to time. ***Be sure to check that your*** `euclid` ***account automatically forwards e-mail to your*** `qmail.cuny.edu` ***e-mail address.*** See page 6 of this document for instructions on how to do this. E-mail forwarding is not 100% reliable; some forwarded e-mail may be blocked or removed as spam. So you should check e-mail on `euclid` ***at least twice a week***: You can do this by entering `alpine -i` on `euclid` after you logon. Logging on to euclid at least twice a week will also reduce the risk of your forgetting your euclid password.

---

[7] See, e.g., https://www.computerhope.com/issues/ch000549.htm if you don't know how. For a typical installation of the Java 17.0.2 JDK, `c:\program files\java\jdk-17.0.2\bin` is likely to be the directory that should be added to your PATH.

[8] For example, you can copy the file `myfile.lsp` from your current working directory on `venus` / `mars` or a PC into your home directory on `euclid` by entering `scp myfile.lsp xxxxx_yyyy316@euclid.cs.qc.cuny.edu:` on `venus` / `mars` or in a powershell window on your PC; here `xxxxx_yyyy316` means your username on `euclid`. (*Note that* `.edu` *is followed by a colon here.*) This command can also be used in a terminal window on a Mac to copy `myfile.lsp` from your working directory on the Mac to `euclid`.

[9] The ***actual*** due date of each of these assignments will be stated in another document that gives details of the assignment; that document will be provided to you at least one week before the actual due date (and often sooner).

C SCI 316 (M W 1:40, 5:00, and 8 pm Sections): Preliminary Schedule

1 1/31 M Information about the course.

2 2/02 W Functional Programming.

3 2/07 M Functional Programming. Lisp: Introduction.

4 2/09 W Lisp: Atoms & lists. Some primitives.

5 2/14 M Lisp: Primitives (contd.). DEFUN.

6 2/16 W Lisp: Predicates, COND/IF.

2/21 M Presidents' Day: College is closed.

7 2/23 W Lisp: AND/OR, LET/LET*.

8 2/28 M Lisp: Recursion.

9 3/02 W Lisp: Recursion (contd).

10 3/07 M Lisp: Recursion (contd).

11 3/09 W Lisp: Recursion (contd).

12 3/14 M Lisp: Functions as arguments,
MAPCAR, REMOVE-IF, REMOVE-IF-NOT, LAMBDA, FUNCALL, APPLY.

13 3/16 W Lisp: Functions that return functions. Tail recursion.

14 3/21 M TBA

15-17 3/23 W – 3/30 W Syntax of Programming Languages.

18 4/04 M **Tentative date of Exam 1.**

19 4/06 W Syntax of Programming Languages (contd.).

20–21 4/11 M & 4/13 W TinyJ project: lexical analysis and recursive descent parsing.

4/15 F – 4/22 F Spring Recess: No Classes.

22-25 4/25 M – 5/04 W TinyJ project: static, stack- & heap-dynamic storage allocation.
hand-translation of TinyJ source code into
TinyJ virtual machine code; compilation of
TinyJ statements, expressions, and methods into
TinyJ virtual machine code.

26-27 5/09 M & 5/11 W TinyJ project: execution of TinyJ virtual machine code.
Parameter passing modes.

28 5/16 M **Probable date of Exam 2.**

2-Hour Cumulative Final Exam:
1:40 pm Section: Wednesday, 5/18, 1:45 – 3:45 (date & time still subject to change)
5:00 pm Section: Wednesday, 5/18, 4:00 – 6:00 (date & time still subject to change)
8:00 pm Section: Date & time will be announced later.

Last day to drop the course with a grade of W: Tuesday, 5/17

This schedule is preliminary and subject to change. However, any change in the date of an exam will be announced at least one week before the new date.

Accounts on `venus` / `mars` (`mars.cs.qc.cuny.edu` or `149.4.211.180`)

You have a Linux account on the machine **`venus`** (which is also called **`mars`**). In many if not all cases your **`venus`** / **`mars`** username is as follows:

first 2 letters of your *last* name (in lowercase) followed by
first 2 letters of your *first* name (in lowercase) followed by
last 4 digits of your 8-digit CUNYfirst ID.

Example: Washington, George CUNYfirst ID: 12345678
Username: `wage5678`

If you have used this account before (in another course), then your password is probably the same as it was when you last used the account. If not, then your initial password is probably your 8-digit CUNYfirst ID#.

Note: Don't confuse your **`venus`** / **`mars`** account with your **`euclid`** account; **`euclid`** and **`venus`** / **`mars`** are different machines. Your **`euclid`** account has a ***different username*** and a ***different password*** from your **`venus`** / **`mars`** account! All assignments must be submitted on **`euclid`**.

The ***simplest*** ways to log on to **`venus`** / **`mars`** from a PC and a Mac are described in the sections* Logging onto your linux account using Windows PowerShell and Logging onto your linux account using Mac that are ***near the bottom*** of the following webpage: **https://venus.cs.qc.cuny.edu/~xiuyi/**

Similarly, the section Transferring files between your computer (Mac terminal or Windows PowerShell) and your linux account of the same webpage **https://venus.cs.qc.cuny.edu/~xiuyi/** describes how you can transfer files between a PC or a Mac and **`venus`** / **`mars`**.

It is important that you be able to log on to `venus` / `mars`. Make sure you can do that *before* our second class meeting: If you cannot log on to your venus / mars account, then email the CS Department's Assistant Systems and Network Manager Xiuyi Huang at `xiuyi.huang@qc.cuny.edu` to ask for help.*
Note: This applies ***only*** to **`venus`** / **`mars`**—if you can log on to **`venus`** / **`mars`** but need help with your **`euclid`** account, then make an appointment to see me during one of my office hour periods.

***If you are outside the United States**, you might not be able to connect to venus / mars unless you use a VPN client. The following two documents provide instructions for installing the **PaloAlto GlobalProtect** VPN client on your PC or Mac and using it to connect to QC's network:

PC: `https://support.qc.cuny.edu/support/solutions/articles/15000019079`
Mac: `https://support.qc.cuny.edu/support/solutions/articles/15000019085`

While connected to QC's network, you can log on to venus / mars using the instructions in the sections Logging onto your linux account using Windows PowerShell and Logging onto your linux account using Mac that are near the bottom of the above-mentioned webpage **https://venus.cs.qc.cuny.edu/~xiuyi/**.

CSCI 316 (M W 1:40, 5:00, and 8 pm Sections): Accounts on euclid and E-mail Forwarding

In addition to your **venus** account, you have an account on **euclid**; **venus** and **euclid** are different machines. Your **euclid** account has a ***different username*** and a ***different initial password*** from your **venus** account. You will need your **euclid** account to submit assignments. I will e-mail important course-related information to everyone's **euclid** account; by default, such email will be forwarded to your qmail.cuny.edu address. **IMPORTANT:** E-mail forwarding is ***not*** 100% reliable; some forwarded e-mail may be blocked or removed as spam. For this reason, and to reduce the risk of forgetting your euclid password, be sure to **check e-mail on euclid at least twice a week---you can do this by entering alpine -i on euclid after you log on.**

If you registered for the class ***before*** 1/30, your username is **xxxxx_yyyy316**, where:

xxxxx = **your last name in lowercase if it has ≤ 5 letters (omit any space or hyphen in the name)**
xxxxx = **first 5 letters of your last name in lowercase if it has > 5 letters**
yyyy = **your first name (as shown on the attendance sheet) in lowercase if it has ≤ 4 letters**
yyyy = **first 4 letters of your first name in lowercase if it has > 4 letters**

Examples: David Touretzky -> toure_davi316 Ada Lovelace -> lovel_ada316 Ravi Sethi -> sethi_ravi316

Your initial password is **q followed by the last 7 digits of your CUNYfirst ID**.
Example: If your CUNYfirst ID is 12345678, then q2345678 is your initial password.

The first time you log on, you will be asked to choose a new password, **so think of a good password in advance**--see, e.g., https://computing.cs.cmu.edu/security/security-password.html.

Assuming you are already logged on to venus, you can log on to euclid by entering
ssh ?????_????316@euclid
at venus's shell prompt; here ?????_????316 means your euclid username.*
If you get a "Host key verification failed." error, retry *after entering this*: /home/faculty/ykong/316setup

The ***first*** time you use ssh on **venus** to connect to **euclid** you will be asked if you trust **euclid**'s "key fingerprint": Answer **yes**. You will then be prompted for your euclid password: **Enter q followed by the last 7 digits of your CUNYfirst ID.** **NOTE:** ***No characters should appear on the screen when you type the password at a "... password:" prompt--the cursor should not move--but the system will know what keys you pressed! Remember to press ENTER at the end.***

You will have to change your password, but must first ***re-enter*** your q ... password:

Changing password for ?????_????316.
(current) UNIX password:

At this prompt, **enter q followed by the last 7 digits of your CUNYfirst ID one more time** and then you will be prompted for a new password:

New password:

Now enter a new password. You'll be asked to re-enter the new password for verification:

Retype new password:

If you re-enter your new password correctly, **your password will be changed and you will be logged off**. Immediately log on to **euclid** again (using your ***new*** password!) and then:

1. Enter the command **finger ?????_????316** (where **?????_????316** means your **euclid** username) and check that the **"Mail forwarded to"** line shows your email is being forwarded to your qmail.cuny.edu address: If you do not see a **"Mail forwarded to"** line, or it shows an incorrect email address, let me know!
2. Enter the command **xc** on **euclid**.
3. Enter the command **alpine -i** on **euclid** and check that an email with the subject "Automatically Generated Reply" is listed in your alpine message index; also make sure you can read the email. After that, **type q and then type y to quit alpine.**
4. A copy of the same email should have been forwarded to your qmail.cuny.edu address. Check your qmail account to make sure the email was successfully forwarded. (If you do not see the email in your qmail account, look in your Junk Email folder.)

If you do 1 - 4 no later than **Thursday, Feb. 10****, then you will receive 0.25 pt. extra credit: I will substitute $a+0.25$ and $b+0.25$ for a and b in grading rules **A** and **B** when I compute your grade for the course.

***The first time** you log on to your **euclid** account, I recommend you do so by ssh from **venus**. (After you have verified that you can log on to euclid via venus, you may in future prefer to connect to **euclid** using an ssh client on your PC or Mac--e.g., follow the Logging onto your linux account using Windows PowerShell instructions or the Logging onto your linux account using Mac instructions near the bottom of the page https://venus.cs.qc.cuny.edu/~xiuyi/ but replace **mars** with **euclid** in those instructions.)

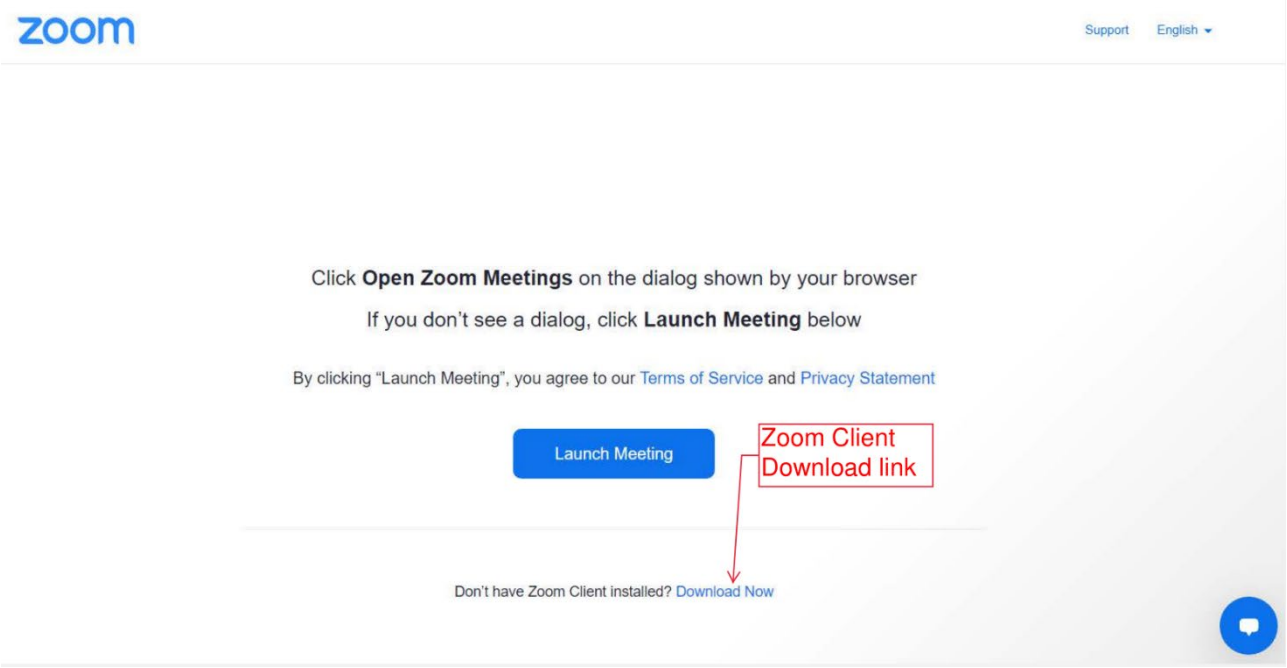
****If you don't do 1 - 3 by Feb. 10, your account may be deactivated** (for security reasons). **To reactivate a deactivated account, or to reset a forgotten password, you must see me after class or during an office hour meeting. [Note that I will *not* reactivate accounts or reset passwords in response to e-mail messages.]**

How to Enter the Zoom Meeting Room for this Course

The Zoom meeting room for the course will be used for office hour meetings.

Here is one way to enter the Zoom meeting room:

1. Point your browser to: https://cuny.zoom.us/signin
2. When the CUNY Web Applications Login page appears, sign in with your CUNYfirst login credentials.
3. Click on JOIN A MEETING near the top right corner of the Zoom page that appears.
4. Type the following into the Meeting ID text box: 316 000 1000 Then click the Join button.
5. Skip this step if the Zoom Client is already installed on your computer. But if the Zoom Client is ***not*** already installed on your computer, then it should be installed. An installer may download automatically; if not, then you can click on the download link on the **Open Zoom Meetings** page:



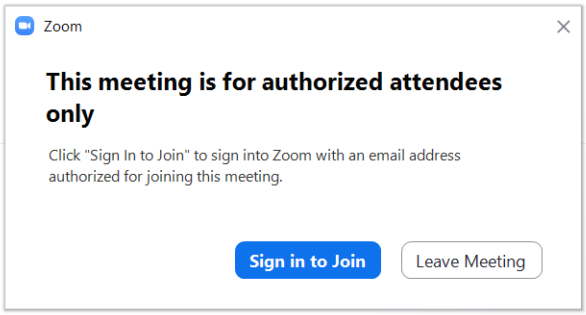
Note: After downloading, you may need to open the downloaded exe or pkg file to install the Zoom Client.

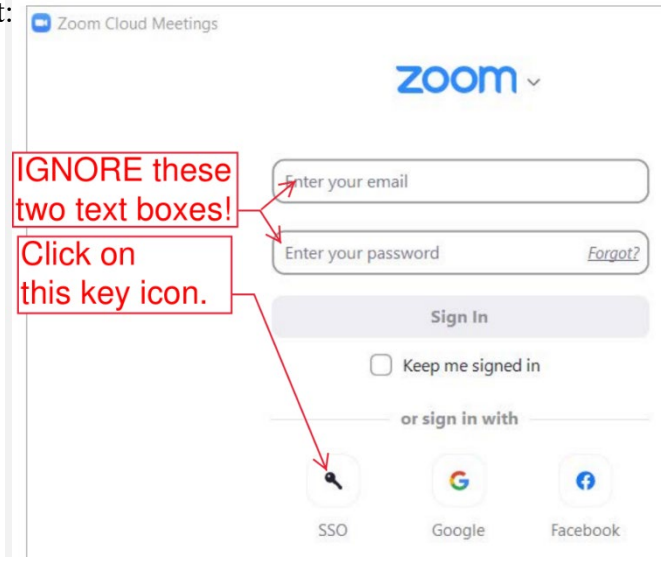
6. If necessary, click Open Zoom Meetings in the dialog shown by your browser or, if you don't see a dialog, click the Launch Meeting button.
7. If you are asked for a passcode, type in the passcode cs316 and then click the Join Meeting button.

Another way to enter the same Zoom meeting room is as follows:

1. Point your browser to: https://cuny.zoom.us/join
2. Type the following into the Meeting ID text box: 316 000 1000 Then click the Join button.
3. If the Zoom Client is not already installed on your computer, then it should be installed—see step 5 above.
4. If necessary, click Open Zoom Meetings in the dialog shown by your browser or, if you don't see a dialog, click the Launch Meeting button.

5. If an "**authorized attendees only**" window (like the one shown on the right) pops up, click the Sign in to Join button and then click on the key icon above SSO in the window that pops up next:





6. If a "**Sign In with SSO**" window like the one shown on the right pops up, type cuny into the text box where "Enter your company domain" appears and click the Continue button.
7. If the CUNY Web Applications Login page appears, sign in with your CUNYfirst credentials.
8. If you are asked for a passcode, type in the passcode cs316 and then click the Join Meeting button.