

CS222-Data Structures and Algorithms

Course Introduction

Dr Govindha R Yeluripati

Outline

- Understanding the importance
- Objectives and Outcomes
- Pre-requisites
- Resources
- Facilitators
- Schedule
- Software
- Topics
- Assessment and Evaluation
- Policies

Before we begin

- Consider the following problem:

Given a group of N numbers, determine the k^{th} largest.
(This is called the Selection problem)

Reading: Section 1.1 of T2

Before we begin

- Solution 1 (Selection problem):
 - 1) Read the N numbers into an array
 - 2) **Sort** the array in decreasing order by some simple algorithm (e.g., bubble sort)
 - 3) Return the element in the position k

Before we begin

- Solution 2 (Selection problem): Slightly better

- 1) Read the first k elements into an array
- 2) **Sort** them in decreasing order
- 3) Read each of the remaining elements one by one.

As a new element arrives, it is ignored if it is smaller than the k th element in the array. Otherwise, it is placed in its correct spot in the array, bumping one element out of the array.

- 4) When the elements end, the element in the k th position is returned as the answer

Before we begin

- Which of the two solutions is better?
- Remember: both work
- Think about huge input: $N = 30,000,000$, $k = 15,000,000$
- A simulation shows that each of these algorithms requires several days to finish
- Can we do any better?
YES, we study an algorithm in our course that can finish within a second
(Quick sort)

Some questions to think...

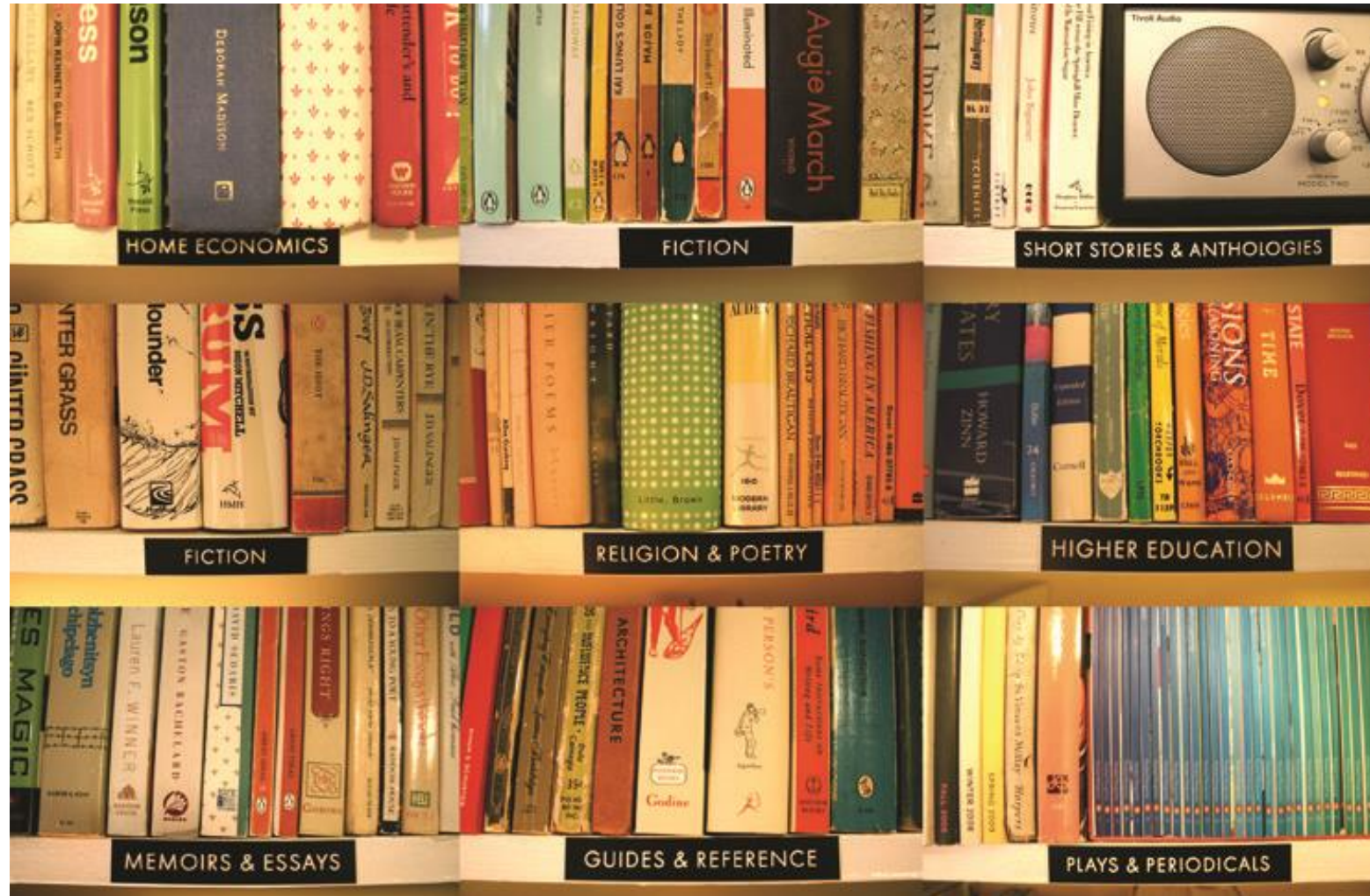
- Okay, in the previous problem (selection), how did you **store** the elements?
- Does the way of storing matter?
- What are the popular ways/methods of storing data in computer memory (can be RAM/Disk)?
- Will it have any impact on the efficiency of the application?

Let's understand more with a practical problem



- Suppose that your library of books is completely unorganized, and you need to pick the Data Structures and Algorithms book written by Dr Govindha Yeluripati

Let's understand more with a practical problem



Let's understand more with a practical problem



Some more practical problems...

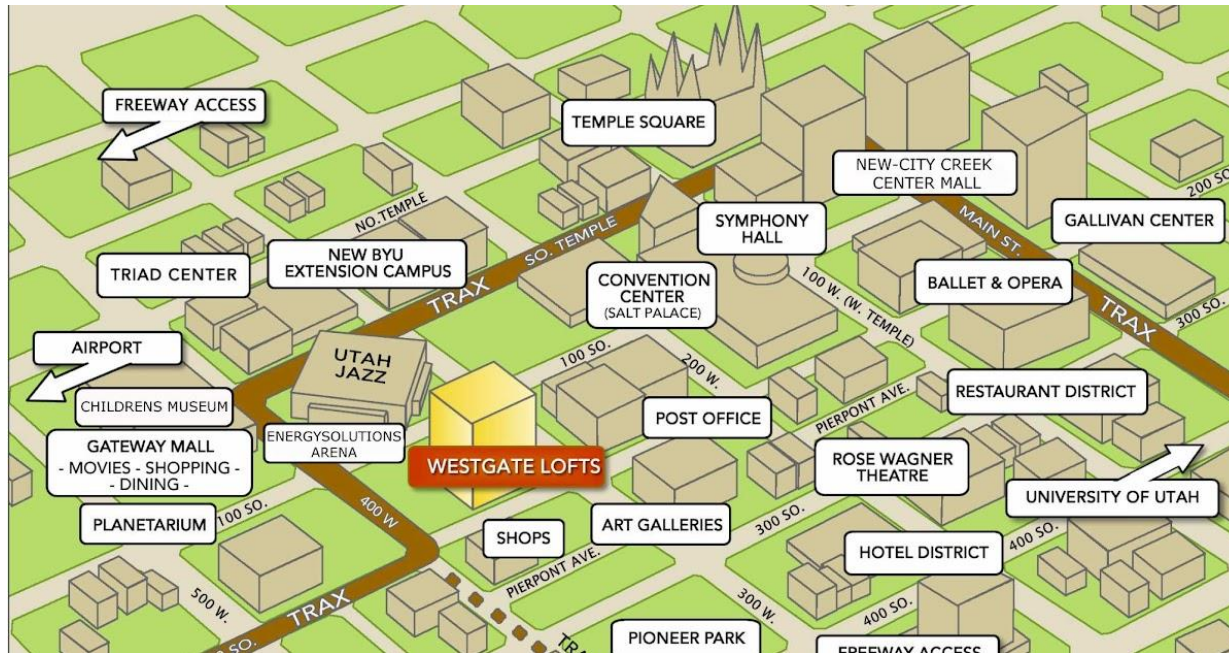
- Why is it easy to look for a word in a dictionary?



- Because it contains a **sorted** list of words

Some more practical problems...

- Why is it easy to look for a place/direction/way if you have a city map?



- Because the information is well organized with the required details such as position/coordinates, distance and names.

Some more practical problems...

- How is the information about the daily cash spending of a business stored/organized?

Cash					
	Date	Description	Increase	Decrease	Balance
	Jan. 1, 20X3	Balance forward			\$ 50,000
	Jan. 2, 20X3	Collected receivable	\$ 10,000		60,000
	Jan. 3, 20X3	Cash sale	5,000		65,000
	Jan. 5, 20X3	Paid rent		\$ 7,000	58,000
	Jan. 7, 20X3	Paid salary		3,000	55,000
	Jan. 8, 20X3	Cash sale	4,000		59,000
	Jan. 8, 20X3	Paid bills		2,000	57,000
	Jan. 10, 20X3	Paid tax		1,000	56,000
	Jan. 12, 20X3	Collected receivable	7,000		63,000

- A well-structured tabular format.

So, what's the observation?

- Does the arrangement make any difference in searching for the thing/information you are looking for?
- That's exactly what happens when you store/arrange the data in different ways in computer memory.

The CS222 Course

- Data Structures is the most fundamental building block concept in Computer science
- Algorithms is a different but a highly related concept
- Good knowledge of data structures and the algorithms used to manipulate them is extremely important to build efficient software systems

CS222-Objectives

This course aims to:

- 1) equip the students with the skills necessary for performing the analysis of algorithms and determining their efficiency using asymptotic notation.
- 2) provide knowledge and understanding of the concept of abstract data types.
- 3) instill the ability to understand, explain, implement, and apply fundamental data structures.
- 4) emphasize the importance of searching and sorting algorithms and study the characteristics of commonly used algorithms by implementing them.

CS222-Learning Outcomes

Upon successful completion of this course, students will be able to:

- 1) analyze, compute, and express the running time of algorithms using asymptotic notation (O , Ω , Θ) and thus determine the efficiency of computer programs.
- 2) explain and implement a variety of commonly used data structures such as stacks, queues, lists, trees, graphs, and hash tables.
- 3) explain and implement prominent searching and sorting algorithms.
- 4) identify and apply appropriate data structures for the solution of real-world problems.
- 5) develop a solid foundation required for pursuing advanced computing courses.

CS222-Prerequisites Information

- Programming knowledge (Java)
- Discrete Structures and Theory (Preferable, not mandatory)
- This course is a pre-requisite for CS456: Algorithm Design and Analysis

CS222: Resources

Textbooks:

- T1:** Goodrich, M. T., Tamassia, R., & Goldwasser, M. H. (2014). Data Structures and Algorithms in Java, Sixth Edition, John Wiley & Sons.
- T2:** Weiss, M.A (2012). Data Structures and Algorithm Analysis in Java, Third Edition, Pearson

CS222: Resources

References:

- R1:** Liang, Y. D (2019). Introduction to Java programming and data structures, Eleventh (Global) Edition, Pearson Education.
- R2:** Cormen, T.H., Leiserson, C.E., Rivest, R.L., & Stein, C (2009). Introduction to Algorithms, MIT Press
- R3:** W. Savitch (2012). Java: An Introduction to Problem-Solving and Programming, Sixth Edition, Prentice Hall.
- R4:** Lafore, R (1998). Data Structures and Algorithms in Java, Waite Group Press.
- R5:** Hubbard, J.H (2007). Data Structures with Java, Schaum's outline series, McGraw Hill.

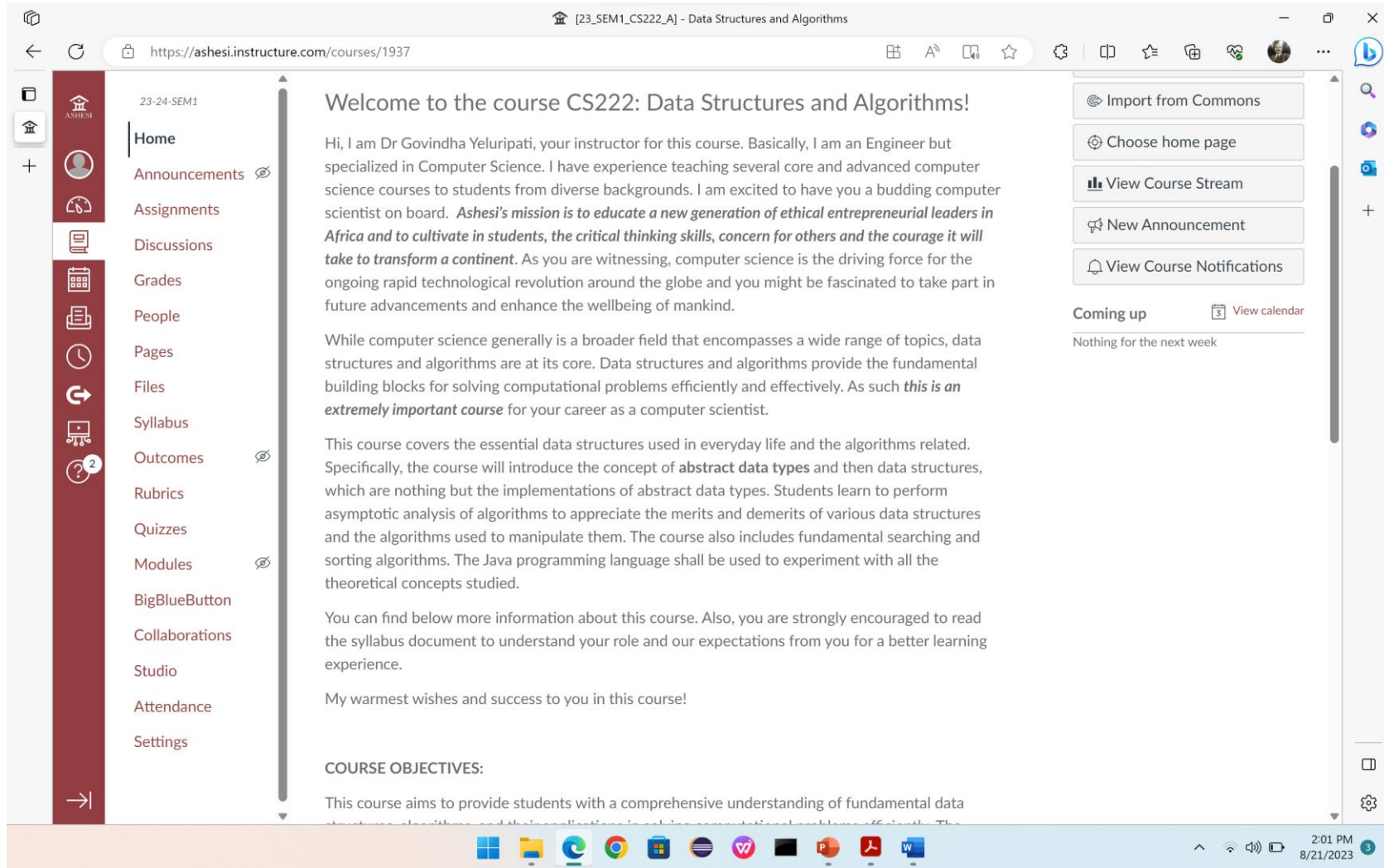
CS222: Resources

Online Tutorials:

- 1) [DSA using Java Tutorial](#)
- 2) [DSA Tutorial](#)
- 3) [DSA Tutorials](#)
- 4) [Data Structures & Algorithms](#)
- 5) [Data Structures and Algorithms in Java \(YouTube\)](#)
- 6) [Data Structures and Algorithms \(YouTube\)](#)
- 7) [Data Structures and Algorithms in Java](#)
- 8) [Data Structures Easy to Advanced \(YouTube\)](#)
- 9) [Foundations of Data Structures \(edX\)](#)
- 10) [Visual Learning Platform](#)
- 11) [Algorithms, Part1\(Coursera\)](#)

CS222: Resources

CANVAS:



The screenshot shows the Canvas LMS interface for the course CS222: Data Structures and Algorithms. The left sidebar contains a navigation menu with options: Home, Announcements, Assignments, Discussions, Grades, People, Pages, Files, Syllabus, Outcomes (with a notification badge), Rubrics, Quizzes, Modules, BigBlueButton, Collaborations, Studio, Attendance, and Settings. The main content area displays a welcome message from Dr. Govindha Yeluripati, the instructor. The message includes a brief introduction, a statement of Ashesi's mission, and a welcome to the course. It also outlines the course objectives, which are to provide students with a comprehensive understanding of fundamental data structures and algorithms. The right sidebar contains a 'Coming up' section with a 'View calendar' link and a 'Nothing for the next week' message. The bottom of the screen shows a Windows taskbar with various application icons and a system clock indicating 2:01 PM on 8/21/2023.

Welcome to the course CS222: Data Structures and Algorithms!

Hi, I am Dr Govindha Yeluripati, your instructor for this course. Basically, I am an Engineer but specialized in Computer Science. I have experience teaching several core and advanced computer science courses to students from diverse backgrounds. I am excited to have you a budding computer scientist on board. *Ashesi's mission is to educate a new generation of ethical entrepreneurial leaders in Africa and to cultivate in students, the critical thinking skills, concern for others and the courage it will take to transform a continent.* As you are witnessing, computer science is the driving force for the ongoing rapid technological revolution around the globe and you might be fascinated to take part in future advancements and enhance the wellbeing of mankind.

While computer science generally is a broader field that encompasses a wide range of topics, data structures and algorithms are at its core. Data structures and algorithms provide the fundamental building blocks for solving computational problems efficiently and effectively. As such **this is an extremely important course** for your career as a computer scientist.

This course covers the essential data structures used in everyday life and the algorithms related. Specifically, the course will introduce the concept of **abstract data types** and then data structures, which are nothing but the implementations of abstract data types. Students learn to perform asymptotic analysis of algorithms to appreciate the merits and demerits of various data structures and the algorithms used to manipulate them. The course also includes fundamental searching and sorting algorithms. The Java programming language shall be used to experiment with all the theoretical concepts studied.

You can find below more information about this course. Also, you are strongly encouraged to read the syllabus document to understand your role and our expectations from you for a better learning experience.

My warmest wishes and success to you in this course!

COURSE OBJECTIVES:

This course aims to provide students with a comprehensive understanding of fundamental data structures and algorithms, and their applications in solving computational problems efficiently. The

CS222: Facilitators

	Instructor	Faculty Intern
Name	<i>Dr. Govindha Ramaiah Yeluripati</i>	<i>Gideon Donkor Bonsu</i>
Email	<i>gyeluripati@ashesi.edu.gh</i>	<i>gideon.bonsu@ashesi.edu.gh</i>
Office Room	205-E	<i>Room 103 (Engineering Building)</i>
Consultation hours	Mondays/Wednesdays, 2-4 PM or <i>by appointment</i>	Mondays/Wednesdays, 2-4 PM or <i>by appointment</i>

CS222: Class Schedule

	Section A	Section B
Lectures	Tuesdays (13:15 – 14:45) Thursdays (13:15 – 14:45)	Tuesdays (15:00 -16:30) Thursdays (15:00 -16:30)
Labs	Fridays (13:50 – 15:20)	Fridays (12:10 -13:40)
Venue	D & B Jackson Hall 221 (for all sessions)	

CS222: Software

- Java Development Kit (JDK) 17 or later, download from [Java Downloads | Oracle](#) and a text editor like Notepad or [Notepad++](#) (recommended for programming).
- Alternatively, you can use any Java IDE you are comfortable with.
- Popular IDEs:
[Eclipse](#), [IntelliJ](#), [NetBeans](#), [BlueJ](#), [JCreator](#), and [jGRASP](#)

CS222: Topics

Week1: Data Structures definition, classification, Simple Data Structures in Java

Week2: Data Abstraction, Classes and Objects, Interfaces, Abstract classes, Generics

Week3: Algorithm analysis, Running time, Asymptotic analysis (O , Ω , Θ)

Week4: Linked lists

Week5: Searching algorithms, Hashing

Week6: Sorting Algorithms (Insertion, Selection, Merge, Quick)

Week7: Recursion, Abstract Data Types (ADT)

Week8: Mid-semester break

CS222: Topics

Week9: List ADT

Week10: Stack ADT

Week11: Queue ADT

Week12: Trees, Binary Search Tree ADT

Week13: Priority Queues (Heaps)

Week14: Graph ADT, Graph Algorithms

Week15: Java Collections Framework

Week16: Revision

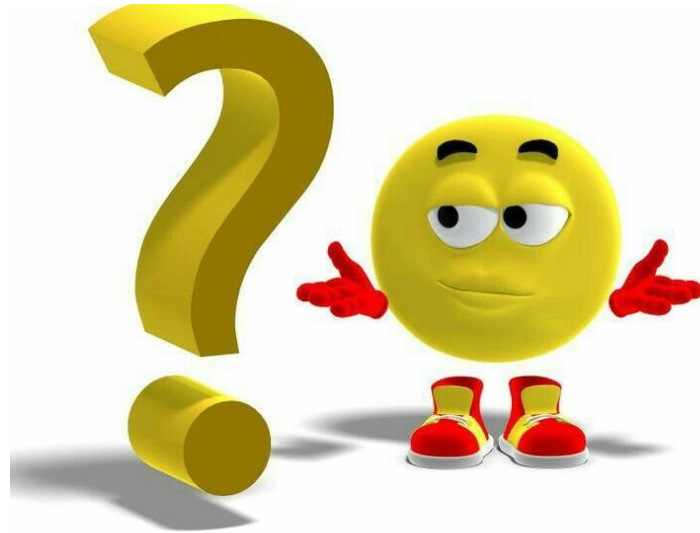
CS222: Assessment and Evaluation

Assessment	Weighting	Timeline
Quizzes (4)	10%	Weeks 3, 7, 11, 15
Lab Exercises (9)	30%	Weeks 1, 2, 4, 6, 9, 10, 11, 12, 14
Mid-Sem Exam	20%	Week 9
Final Project	15%	Week 15
Final Exam	25%	Week 17
Total	100%	End of Semester

Course policies

- GENERAL ACADEMIC POLICIES: It is the student's responsibility to be familiar with and adhere to Ashesi's policies (Ashesi's Student Handbook)
- LATE SUBMISSION POLICY: Assignments submitted late will receive a 10% penalty per 24-hour period
- ATTENDANCE POLICY: Attendance will be marked after 5 minutes of the start of a class. That absence will count towards Ashesi's attendance policy.
- PARTICIPATION: Students are strongly encouraged to interact and participate in discussions
- PROFESSIONALISM: Highly professional and polite behaviour is expected with facilitators and fellow students.

Thank You!



Any questions?