University of Louisville, CSE Department

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Data Structure and Operating System - CSE 503

COURSE SYLLABUS – Summer 2024 - ONLINE

Instructor:

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Office Hours:

Tuesday, Thursday 1:00pm-2:30pm

Prerequisite: CSE 130

Course Description:

Introduction to foundations of computer engineering and computer science for non-majors. Emphasis on C++ programming language, data structures and algorithms, and operating systems fundamentals. The course is not available for credit for students with undergraduate degree in CECS/CS/CSE or close disciplines.

Course Objectives:

After taking this course, the student will be able to:

a. Create programs in the C++ programming language to implement stacks, queues, deques, general lists, hash tables, binary trees, and graphs.
b. Create programs in the C++ programming language to implement efficient algorithms for sorting lists of items.
c. Create programs in the C++ programming language to implement efficient algorithms for searching for a particular key in a list of records.
d. Create programs in the C++ programming language to implement efficient algorithms for traversing binary trees.
e. Understand the concepts and designs of Operating Systems
f. Create programs in the C programming language to implement functions of operating systems

Student Outcomes:

a. An ability to apply knowledge of mathematics, science, and engineering in the field of computer engineering and computer science.
b. An ability to design and conduct experiments, as well as to analyze and interpret data in the field of computer engineering and computer science.
c. An ability to identify, formulate, and solve problems in the field of computer engineering and computer science.
d. Recognition of the need for, and an ability to engage in life-long learning in the field of computer engineering and computer science. (j) A knowledge of contemporary issues in the field of computer engineering and computer science.
e. An ability to use the techniques, skills, and engineering tools for the practice of computer engineering and computer science.

Textbook:

- Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", 4th edition, Addison Wesley, 2013.
- Silberschatz, Galvin, Gagne. "Operating System Concept", 9th Edition, Wiley. 2018

If you are able to find older edition of the books, for the purpose of this course the 3rd edition of Data Structures and Algorithm Analysis in C++ and the 7th edition of Operating System Concept both works.

Grading Policy:

There will be 10 homework assignments, each worth 10 points. The homework assignments will include small programming exercises and book questions. There will be 2 programming projects, each worth 100 points. There will be a midterm exam and a final exam. Each exam is worth 100 points. The score percentage breakdown for homework, projects and tests are:

Two Tests	(20%+20%)	40%
Two Projects	(20% + 20%)	40%
Homework		20 %
		=====
	Total	100 %

Grading Scale:

A	90% & up
B	80% - 89.99%
C	70% - 79.99%
D	60% - 69.99%
F	below 60%

Academic Dishonesty

Academic dishonesty is prohibited at the University of Louisville. It is a serious offense because it diminishes the quality of scholarship, makes accurate evaluation of student progress impossible, and defrauds those in society who must ultimately depend upon the knowledge and integrity of the institution

and its students and faculty.
For more information, visit the Code of Student Rights and Responsibilities (Sections 5. and 6.).

Students with Disabilities:

The University of Louisville is committed to providing access to programs and services for qualified students with disabilities. If you are a student with a disability and require accommodation to participate and complete requirements for this class, notify me immediately and contact the Disability Resource Center (Stevenson Hall, 502.852.6938) for verification of eligibility and determination of specific accommodations.
For more information, visit the Disability Resource Center

Oral and written communication requirements:

There will be no oral or written communication requirements beyond homeworks, tests, projects, and blackboard discussions.

Computer Issues and IT Support

Speed IT staff are available by appointment from 9 am to 4 pm to assist you with your technology needs. You may schedule an appointment by sending a detailed email including any relevant error codes and screen snips at SPDHelp@Louisville.edu (preferred) or 502-852-7620.

Title IX/Clery Act Notification

Sexual misconduct (including sexual harassment, sexual assault, and any other nonconsensual behavior of a sexual nature) and sex discrimination violate University policies. Students experiencing such behavior may obtain **confidential** support from the PEACC Program (852-2663), Counseling Center (852-6585), and Campus Health Services (852-6479). To report sexual misconduct or sex discrimination, contact the Dean of Students (852-5787) or University of Louisville Police (852-6111).

Disclosure to University faculty or instructors of sexual misconduct, domestic violence, dating violence, or sex discrimination occurring on campus, in a University-sponsored program, or involving a campus visitor or University student or employee (whether current or former) is **not confidential** under Title IX. Faculty and instructors must forward such reports, including names and circumstances, to the University's Title IX officer. For more information, see http://louisville.edu/hr/employeerelations/sexual-misconduct-brochure.

Religious Holy Days and Observances

Federal law and university policy prohibit discrimination on the basis of religious belief. It is the policy of the University of Louisville to accommodate students, faculty, and staff who observe religious work-restricted holy days. Students who observe work-restricted religious holy days must be allowed to do so without jeopardizing their academic standing in any course. Faculty are obliged to accommodate students' request(s) for adjustments in course work on the grounds of religious observance, provided that the student(s) make such request(s) in writing during the first two (2) weeks of term. Deans and department chairs must investigate and resolve student complaints arising from alleged faculty failure to make reasonable accommodations under these guidelines.
For more information, view the Calendar and Policy on Religious Holy Days and Observances.

Statement on Diversity

The University of Louisville strives to foster and sustain an environment of inclusiveness that empowers us all to achieve our highest potential without fear of prejudice or bias. We commit ourselves to building an exemplary educational community that offers a nurturing and challenging intellectual climate, a respect for the spectrum of human diversity, and a genuine understanding of the many

differences-including race, ethnicity, gender, gender identity/expression, sexual orientation, age, socioeconomic status, disability, religion, national origin or military status-that enrich a vibrant metropolitan research university.

We expect every member of our academic family to embrace the underlying values of this vision and to demonstrate a strong commitment to attracting, retaining and supporting students, faculty and staff who reflect the diversity of our larger society.
For more information, visit the Office of Diversity.

Tentative Schedule:

The following is the tentative schedule of topics, which will be covered during the semester**. Please check announcement and weeks** under course content/schedule frequently for exact due dates assignments when they are available on The Blackboard.

Week 1 *- UNIT 1:* **Math Review**

This unit will review basic math concept, including: Logarithms, Modular Arithmetic, Exponents, and Functions.

a) Required reading:

- Data Structure Textbook: Chapter 1: "Introduction", pp. 1-41.

Week 1 *- UNIT 2:* **Algorithm Analysis**

This unit will cover Big O notation and run time analysis of algorithms.

a) Required reading:

- Textbook: Chapter 2: "Algorithm Analysis", pp. 43-69.

b) Additional reading:

- P versus NP problem
http://en.wikipedia.org/wiki/P_versus_NP_problem

c) Assignments:

- Homework 1 (Unit 1 & 2) (Extra Credit): Book "Data Structure and Algorithm Analysis in C++"

P. 40 1.7, 1.10

p. 64 2.1, 2.3, 2.4, 2.6, 2.7, 2.22

Detailed instruction see Blackboard->Assignments->Homework 1

Due Monday, Week 2.

Week 2 *- UNIT 3:* **Lists, Stacks and Queues**

This unit will cover concept of Linked List, implementation of Linked List, concept of Stack, operations on Stack, implementation of Stack, concept of Queue, operations on Queue and implementation of queue.

a) Required reading:

- Slides for Unit 3: Chapter_03.ppt
- Videos for Unit 3:

  Chapter_03_01.mov, Chapter_03_02.mov, Chapter_03_03.mov

- Textbook: Chapter 3: "List, Stack, and Queues", pp. 71-108.

b) Additional reading:

- Stack Visualization:
  Array Implementation: https://www.cs.usfca.edu/~galles/visualization/StackArray.html
  Linked List Implementation:
  https://www.cs.usfca.edu/~galles/visualization/StackLL.html

- Queue Visulization
  Array Implementation: https://www.cs.usfca.edu/~galles/visualization/QueueArray.html
  Linked List Implementation:
  https://www.cs.usfca.edu/~galles/visualization/QueueLL.html

c) Assignments:

- Homework 2 (Unit 3): *Implement stack and queue*

Detailed instruction see Blackboard->Assignments->Homework 2

Due Monday, Week 3.

Week 3 *- UNIT 4:* **Tree**

This unit will cover concept of Binary Search Tree, implementations of binary search tree, tree search and tree traversal.

a) Required reading:

- Slides for Unit 4: Chpater_04.ppt
- Videos for Unit 4:

Chapter_04_01.mov, Chapter_04_02.mov, Chapter_04_Examples.mov

- Textbook: Chapter 4: "Trees", Section 4.1 – 4.4, 4.6

b) Additional reading:

- Binary search tree visualization: https://www.cs.usfca.edu/~galles/visualization/BST.html
- Self-Balancing tree visualization: https://www.cs.usfca.edu/~galles/visualization/AVLtree.html
- More on AVL trees: https://www.cs.auckland.ac.nz/~jmor159/PLDS210/AVL.html
- Application of tree data structure http://www.geeksforgeeks.org/applications-of-tree-data-structure/

c) Assignments:

- *Homework 3 (Unit 4): Implement Binary search tree*

Detailed instruction see Blackboard->Assignments->Homework 3

Due Monday, Week 4

UNIT 6: **Heaps**

This unit will cover concept of Heaps, implementation of Heaps, operations on Heaps and Heap traversal.

a) Required reading:

- Slides for Unit 6: Chapter_06.ppt

- Videos for Unit 6:

Chapter_06.mov

- Textbook: Chapter 6: "Priority Queues (Heaps)", Section 6.1-6.6.

b) Additional Reading

- Visualize Heap: https://www.cs.usfca.edu/~galles/visualization/Heap.html
- Application of Heap: http://webdocs.cs.ualberta.ca/~holte/T26/heap-uses.html

c) Assignments:

Project 1:

Implement a Simple Search Words Suggestion Engine:

A dictionary file will be provided. The file contains all recommended search sentences. When user start typing out a sentence, auto-complete the sentence with the most plausible

sentences in the dictionary. An example of this is google search. Notice as you type a word google auto complete the search sentence for you.

Detailed Instruction see Blackboard->Assignments->Project 1

Due Monday, Week 6

Week 4 *- UNIT 5:* **Hashing**

This unit will cover concept of Hash function, collision detection and implementation of hash.

a) Required reading:

- Slides for Unit 5: Chapter_05.ppt
- Videos for Chapter 5:

  Chapter_05_01.mov, Chapter_05_example.mov

- Textbook: Chapter 5: "Hashing" pp. 185-211

b) Additional Reading

- Cryptographic Hash Function:
  https://www.youtube.com/watch?v=a5F16sM75uY
  https://www.youtube.com/watch?v=b4b8ktEV4Bg
- Hash collision attack
  https://en.wikipedia.org/wiki/Collision_attack

c) Assignments:

- *Homework 4 (Unit 5): Implement Hashing*

Detailed instruction see Blackboard->Assignments->Homework 4

Due Monday, Week 5.

Week 5 *- UNIT 7:* **Sorting**

This unit will cover basic comparison based sorting algorithm including: selection sort, bubble sort, merge sort and quick sort.

a) Required reading:

- Slides for Unit 7: Chapter_07.ppt
- Videos for Unit 7:

Chapter_07_01.mov, Example_01.mov, Chapter_07_02.mov, Example_02.mov

- Textbook: Chapter 7: "Sorting", pp. 261-311.

b) Additional Reading

- Different Sorting Algorithm: http://www.sorting-algorithms.com/
- Sorting Lower Bound nlog(n): https://class.coursera.org/algo-004/lecture/40
- Why Quick sort usually is quickest: http://cs.stackexchange.com/questions/3/why-is-quicksort-better-than-other-sorting-algorithms-in-practice
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c) Assignments:

(from the book) [details will be added in the blackboard in the week]

Week 6 *- UNIT 9:* **Operating System Structures**

This unit will cover operating system structures including shell, kernel, syscalls.

a) Required readings:

- Slides for Unit 9
- Textbook: Chapter 2: "Operating System Structure", Sections 2.1-2.7.

b) Additional Reading

- Beginner guide for Linux Operating System: https://www.linux.com/learn/tutorials/784060-the-complete-beginners-guide-to-linux
- Tutorial for Linux Operating System: http://www.ee.surrey.ac.uk/Teaching/Unix/

Week 6 - Exam 1

Exam 1 will be given on Thursday of Week 6. Once you open the exam, you have 1 hour and 30 minutes to complete the exam. You only have 1 attempt on finishing the exam.

Topics from unit 1 – 8 will be on the exam

Week 7 *- UNIT 10:* **Processes**

This unit will cover the concept of process in an operating system setting and operations on processes.

a) Required reading:

- Slides for Unit 10
- Textbook: Chapter 3: "Processes", Section 3.1 - 3.3.

b) Additional Reading

- Processes concept: https://www.youtube.com/watch?v=r3jYC80Pm_Q&index=6&list=PLTZbNwgO5ebqnympIYe2GX4hjjsS9Psdm
- Processes chapter from "Operating Systems: Three Easy Pieces" : http://pages.cs.wisc.edu/~remzi/OSTEP/cpu-intro.pdf
- Visualization of processes http://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/3_Processes.html
- How fork() syscall work: https://www.youtube.com/watch?v=AnViPd8l6Oc

c) Assignments:

- *Homework 6 (Unit 9 and Unit 10): Structure and Forking*

  from Book "Operating System Concepts"

Detailed instruction see Blackboard->Assignments->Homework 6

Due Monday, Week 10.

UNIT 11: **Threads**

This unit will cover concept of threads, operation on threads and multi-threaded programming.

a) Required reading:

- Slides for Unit 11
- Textbook: Chapter 4: "Threads", Sections 4.1 - 4.4.

b) Additional Reading

- Tutorial on pThread http://randu.org/tutorials/threads/
- Multithread in Java http://www.buyya.com/java/Chapter14.pdf
- volatile keyword to help with multithreads in C++ http://www.drdobbs.com/cpp/volatile-the-multithreaded-programmers-b/184403766

c) Assignments:

- *Homework 7 (Unit 11): pThread*

  Create a program that compute summation in multiple thread.

Detailed instruction see Blackboard->Assignments->Homework 7

Due Monday, Week 11.

Week 8 *- UNIT 12:* **CPU Scheduling**

This unit will cover basic concept of scheduling, criteria for scheduling and several scheduling algorithms such as Round Robin algorithm

a) Required reading:

- Slides for Unit 12
- Textbook: Chapter 5: "CPU Scheduling", 5.1 – 5.7.

b) Additional Reading

- CPU scheduling visualization
  http://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/5_CPU_Scheduling.html
- Notes on CPU scheduling
  http://people.csail.mit.edu/rinard/osnotes/h6.html
- CPU scheduling algorithms
  https://www.youtube.com/watch?v=6TxXA3hbX8Y

c) Assignments:

Project 2:

Simulate a process scheduler:

A file containing a list of jobs to be done by CPU is provided as input. Each row of the job file contains job request time and duration. Write a CPU scheduler simulator to schedule these jobs and print out the scheduled order of execution.

Detailed Instruction see Blackboard->Assignments->Project 2

Week 9 *- UNIT 13:* **Process Synchronization**

This unit will cover the issue of parallel processing and deadlock and how to avoid deadlock using lock/unlock mechanisms such as mutex and semaphore.

a) Required reading:

- Slides for Unit 12
- Textbook: Chapter 6: "Process Synchronization", Section 6.1 - 6.3.

b) Additional Reading

- Deadlock visualization
  http://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/7_Deadlocks.html
- How to prevent deadlock in C++
  http://www.drdobbs.com/parallel/use-lock-hierarchies-to-avoid-deadlock/204801163
- C++ tutorial on preventing deadlocks
  http://www.bogotobogo.com/cplusplus/C11/9_C11_DeadLock.php

c) Assignments:

- *Homework 8 (Unit 12 & Unit 13)*

  from Book "Operating System Concepts"

Detailed instruction see Blackboard->Assignments->Homework 8

Due Monday, Week 10.

Week 10 - *UNIT 14:* **Main Memory**

This unit will cover the structure and management of physical memory in an operating system.

a) Required reading:

- Slides for Unit 13
- Textbook: Chapter 8: "Main Memory", Section 8.1 – 8.6

b) Additional Reading

- In-memory computing
  http://www.gridgain.com/in-memory-computing-in-plain-english/
- More on memory management
  https://www.youtube.com/watch?v=qdkxXygc3rE
- Memory management in C++
  http://www.embeddedstar.com/technicalpapers/pdf/Memory-Management.pdf

c) Assignments:

- Homework 9 (Unit 14):

  from *Book "Operating System Concept"*

  Detailed instruction see Blackboard->Assignments->Homework 9

  Due Monday, week 14

-*UNIT 15:* **Virtual Memory**

This unit will cover the concept and management of virtual memory.

a) Required reading:

- Slides for Unit 14
- Textbook: Chapter 9: "Virtual Memory ", Section 9.1 – 9.6.

b) Additional Reading

- More on virtual memory
  https://www.youtube.com/watch?v=DlDBqHuvAUw

c) Assignments:

Homework 10 (Unit 15):

from *Book "Operating System Concept"*

Detailed instruction see Blackboard->Assignments->Homework 10

Due Monday, Week 15.

Reminder: Project 2 Due Monday in this week.

Exam 2

Exam 2 date pending.