Syllabus: CS 330 Algorithms and Data Structures

COURSE CODE / COURSE LEVEL: CS 330
Decided and approved by the Department in line with existing course coding; this is done prior to submission to Academic Council

COURSE NAME: *Algorithms and Data Structures*

TOTAL NO. OF CONTACT HOURS: 45
CREDITS: 3

PREREQUISITES: One previous course in Computer Science

COURSE DESCRIPTION
This course covers the main principles of algorithm design, introducing fundamental data structures and basic algorithmic techniques. It also discusses how to perform an analysis of algorithms, to establish their correctness and evaluate their efficiency. The emphasis is on choosing appropriate data structures and designing correct and efficient algorithms to operate on them, following standard algorithmic techniques. Principles of complexity theory and challenges arising in modern application domains are also investigated.

SUMMARY OF COURSE CONTENT

This course will introduce the basic principles and techniques for the design, analysis, and implementation of efficient algorithms and data representations.

It will first define the concept of algorithm and discuss the differences between decision and optimization algorithms. It will then introduce the asymptotic notation for analyzing the efficiency of algorithms and formal methods for establishing their correctness.

The core of the course will then be a discussion of several algorithmic techniques, including greedy algorithms, dynamic programming, integer linear programming, recursion, and divide-and-conquer methods, with examples of applications to combinatorial structures, such as numbers, sets, and graphs. Data structures supporting these techniques will be considered, including arrays, stacks, and queues. The course will be concluded with an introduction to complexity theory and the notion of the hardness of problems, and with a brief analysis of the additional challenges posed by Big Data from the algorithmic perspective.

Required course materials/study visits and expected expenditure for the students

Given the theoretical nature of the course, there is no requirement for specific equipment or for study visits. The only necessity is the possibility of accessing a computer on a regular basis, as the main material will consist of electronic slides, distributed via the Moodle platform.

LEARNING OUTCOMES

Upon successful completion of this course, the student will have:

- understood the main principles of algorithm design
- learnt how to analyse algorithms in terms of efficiency and correctness
- become familiar with fundamental data structures and their implementation
- become accustomed to basic algorithmic techniques to solve problems
- understood the classification of problems based on their complexity.

TEXTBOOK

- *Introduction to Algorithms, Third Edition* by Thomas H. Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein. MIT Press, 2009

Students are not required to purchase the books, which are mainly meant to support the slides provided by the instructor and to be an additional source of exercises and examples.

An electronic version of the book is also available in the JCU Frohring library.

GRADING POLICY

Assessment methods:

Assignment	Guidelines	Weight
Assignments	2 home-assignments and 1 midterm evaluation. Assignments will be evaluated on the quality of the submitted solutions and on a subsequent discussion in class.	35
Paper discussion	An algorithm from a research paper will be assigned to each student, to be presented and discussed in class.	20
Final exam	Verification of the knowledge acquired by the student in the course.	35
Attendance and participation	Attendance and participation are fundamental, due to the creative and theoretical nature of the topics.	10

Assessment criteria:

Grade A characteristics:

Work of this quality directly addresses the question or problem raised and provides a coherent argument displaying an extensive knowledge of relevant information or content. This type of work demonstrates the ability to critically evaluate concepts and theory and has an element of novelty and originality. There is clear evidence of a significant amount of reading beyond that required for the course

Grade B characteristics:

This is highly competent level of performance and directly addresses the question or problem raised. There is a demonstration of some ability to critically evaluate theory and concepts and relate them to practice. Discussions reflect the student's own arguments and are not simply a repetition of standard lecture and reference material. The work does not suffer from any major errors or omissions and provides evidence of reading beyond the required assignments

Grade C characteristics:

This is an acceptable level of performance and provides answers that are clear but limited, reflecting the information offered in the lectures and reference readings.

Grade D characteristics:

This level of performances demonstrates that the student lacks a coherent grasp of the material. Important information is omitted and irrelevant points included. In effect, the student has barely done enough to persuade the instructor that s/he should not fail.

Grade F characteristics:

This work fails to show any knowledge or understanding of the issues raised in the question. Most of the material in the answer is irrelevant.

Grade scale

A	=	94- 100%	B	=	84-86%	C-	=	70-73%
A-	=	90-93%	B-	=	80-83%	D+	=	67-69%
B+	=	87-89%	C+	=	77-79%	D	=	60-66%
			C	=	74-76%	F	=	0-59%

ATTENDANCE REQUIREMENTS:

Attendance is to be considered mandatory and will be part of the final grade. Students will be granted 2 absences without penalty. Any other absences will only be excused with medical certificates or permission from the Dean's Office.

Examination policy

A major exam (midterm or final) cannot be made up without the permission of the Dean's Office. The Dean's Office will grant such permission only when the absence was caused by a serious impediment, such as a documented illness, hospitalization or death in the immediate family (in which you must attend the funeral) or other situations of similar gravity. Absences due to other meaningful conflicts, such as job interviews, family celebrations, travel difficulties, student misunderstandings or personal convenience, will not be excused. Students who will be absent from a major exam must notify the Dean's Office prior to that exam. Absences from class due to the observance of a religious holiday will normally be excused. Individual students who will have to miss class to observe a religious holiday should notify the instructor by the end of the Add/Drop period to make prior arrangements for making up any work that will be missed.

ACADEMIC HONESTY

As stated in the university catalog, any student who commits an act of academic dishonesty will receive a failing grade on the work in which the dishonesty occurred. In addition, acts of academic dishonesty, irrespective of the weight of the assignment, may result in the student receiving a failing grade in the course. Instances of academic dishonesty will be reported to the Dean of Academic Affairs. A student who is reported twice for academic dishonesty is subject to summary dismissal from the University. In such a case, the Academic Council will then make a recommendation to the President, who will make the final decision

STUDENTS WITH LEARNING OR OTHER DISABILITIES

John Cabot University does not discriminate on the basis of disability or handicap. Students with approved accommodations must inform their professors at the beginning of the term. Please see the website for the complete policy

SCHEDULE

Week 1	Introduction to algorithms Analysis of algorithms: asymptotic notation Searching and Sorting	
Week 2	Divide-and-conquer algorithms Recursion Dynamic programming	
Week 3	Basic data structures: array, list, queue, stack Graph search: BFS and DFS Graph optimization: shortest paths	
Week 4	Greedy algorithms Integer linear programming	
Week 5	NP-completeness Handling difficult problems: Approximation, FPT, and Randomized algorithms	

OVERVIEW OF KEY BIBLIOGRAPHIC WORKS FOR THE COURSE

Algorithm Design by Jon Kleinberg and Éva Tardos. Addison-Wesley, 2005.

Algorithms unlocked, by Thomas H. Cormen, MIT Press, 2013

Combinatorics: Topics, Techniques, Algorithms, by Cameron, Peter J. Cambridge University Press, 1994