CS 200 *Discrete Structures*

COURSE CODE / COURSE LEVEL: CS 200

COURSE NAME: *Discrete Structures*

TOTAL NO. OF CONTACT HOURS: 45
CREDITS: 3

PREREQUISITES: Placement into MA 197 or completion of MA 100 or MA 101

COURSE DESCRIPTION

This course introduces the main elements of formal reasoning and its applications to the theory of computation. Starting from the definition of logic statements and elementary structures in discrete mathematics, such as numbers, sets, and graphs, the course discusses the formalization of real-life problems in mathematical and computer science terms.
Mathematical tools will be introduced to infer the validity of complex statements starting from elementary ones and different techniques for deriving formal proofs for theorems will be analyzed. Examples of algorithmic solutions to real-life problems exploiting their formalization will also be presented and discussed, both in terms of correctness and efficiency.

SUMMARY OF COURSE CONTENT

The course will first introduce some notation and tools in the field of propositional logic and deductive reasoning, such as truth tables, logic conjunctions, and implications. Then, it will explore how these tools can be exploited to establish the validity of certain statements and facts, discussing the proof techniques based on deduction and on contradiction.

The next goal will be to discuss certain structures in discrete mathematics that are heavily used in computer science and to study their combinatorial properties. This includes integer numbers, with their binary representation in a computer, permutations, sequences, and series, together with elements of set theory and of graph theory. Using these structures as training fields for various examples, another powerful proof technique based on mathematical induction will be introduced.

Finally, the course will overview some state-of-the-art algorithmic solutions for fundamental computer science problems, such as searching and sorting, and use the techniques learned in the course to formally prove their correctness. To further establish the efficiency of these solutions, basic principles of computational complexity will be presented, including recurrences, counting arguments, and asymptotic notation.

To provide students with a direct research experience, each of them will be assigned a theorem from a research paper, whose statement and proof will be presented and discussed in class.

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 improved their ability to formulate and understand a structured reasoning, according to logical conjunctions and implications,
- will be familiar with the main concepts and notions in discrete mathematics,
- will be able to formalize a real-life problem in mathematics and computer science terms,
- will be acquainted with various techniques to formally prove combinatorial and structural properties of the instances of these problems,
- will have developed basic skills to provide algorithmic solutions for these problems, to analyze them in terms of their correctness, and to evaluate their efficiency.

TEXTBOOK

Koshy, Thomas. 2003. *Discrete Mathematics with Applications.* Elsevier Science & Technology. ISBN: print:9780124211803, ebook:9780080477343.

Students are not required to purchase the book, which is mainly meant to support the slides provided by the instructor and to be an additional source of exercises.
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.	30
Paper discussion	A theorem from a research paper on one of the studied topics will be assigned to each student and discussed in class	20
Final exam	Verification of the knowledge acquired by the student in the course.	40
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	The role of Math in Computer Science Logic: Truth tables, Equivalence, Implications, Paradoxes Representing numbers in computers Proofs by deduction and contradiction	
Week 2	Introduction to set theory Combinatorics: Permutations and combinations Pigeonhole principle Proof by induction on integers and on sets	
Week 3	Introduction to graph theory Trees and planar graphs	
Week 4	Induction proofs on graphs Euler formula for planar graphs	
Week 5	Principles of algorithm analysis Searching and sorting Recurrences	

OVERVIEW OF KEY BIBLIOGRAPHIC WORKS FOR THE COURSE

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

Keller, Mitchel T. and Trotter, William T. 2017. *Applied Combinatorics*. Open-source license: CC-BY-SA. ISBN 13: 9781973702719

Trudeau, Richard J. 1994. *Introduction to Graph Theory*. Dover books in Mathematics.

Gunderson, David S. 2010. *Handbook of Mathematical Induction: Theory and Applications*. Chapman & Hall/CRC.