# DePAUL UNIVERSITY
## COLLEGE OF COMPUTING AND DIGITAL MEDIA

## CSC400 - 701/710 Discrete Structures for Computer Science

## SYLLABUS

**Quarter:** Fall, 2021 -2022
**Class time:** M 5:45 – 9:00
**Location:** 1111 Lewis
**Instructor:** Vladimir Lepetic
**Office:** 1650 Lewis, LC; **Phone:** (312) 362-6250
**e-mail:** vlepetic@depaul.edu
**Office Hours:** M 4:45 – 5:45 by appointment. W 11:00 – 12:00, Zoom by appointment.

**TEXT:** Lehman, E., Leighton, F.T., Meyer, A. R.,(**LLM)**, *Mathematics for Computer Science*, ISBN 978-1680921212, (it's freely available online: *https://courses.csail.mit.edu/6.042/spring18/mcs.pdf* )

In case you have not been previously exposed to any advanced/discrete mathematics I **strongly suggest** you consult the following:

**SUPLEMENTARY READINGS: Epp, S**., *Discrete Mathematics with Applications*, 5th ed. Brooks/Cole Publishing,
(**Note:** There is a 4th edition of Epp's *Discrete Mathematics with Applications*. If you can get the 4th, less expensive edition, you will be perfectly fine.)

**Additional sources where you can find good exposition of the material discussed in this class:**

**Goldrei, D.,** *Classic Set Theory*, Chapman and Hall/CRC, 1996.

**Goldrei, D.,** *Propositional and Predicate Calculus: A Model of Argument*, Springer, 2005

**Epp, S.,** Discrete *Mathematics, An Introduction to Mathematical Reasoning*, Brooks/Cole, 2011.

**Rosen, K**., *Discrete Mathematics and Its Applications*, McGraw-Hill, 2018.

**Lepetic, V**., *Principles of Mathematics: A Primer*, Wiley, 2016

**Johnsonbaugh, R**., *Discrete Mathematics*, Pearson, 2017.

**Chartrand, G., Ping, Z.,** *Discrete Mathematics*, Waveland Pr. Inc., 2017.

**Lipschutz, S., Lipson, M.,** *Discrete Mathematics*, Schaum's Outline of Discrete Mathematics, McGraw-Hill, 2009.

## COURSE DESCRIPTION:

CSC400 is intended to provide a solid foundation for further study of mathematics and computer science.
The course introduces the basic principles of logical reasoning and abstract mathematics and shows how to apply them to explore, formulate and establish truth and falsity for elementary statements in mathematics and computer science. In addition, it extends the development of reasoning skills needed for studies of a variety of the mathematical structures that are needed for advanced mathematics and computer science.
The topics covered include: logic and set theory, relations, functions, graphs, and counting and probability.

## CONTENTS

**O Introduction (EPP Ch.1; LLM Ch.1 Ch.4.1)**

**0.1** Motivation and General Idea
**0.2** What is Proof?
**0.3** Speaking Mathematically
**0.4** The Language of Sets/The Language of Logic

**I Set Theory (EPP Ch. 6.1 – 6.4; LLM Ch.4.1 - 4.5, Ch. 8 (*))**

**6.1** Set Theory: Definitions and the Element Method of Proof
**6.2** Properties of Sets
**6.3** Disproofs, Algebraic Proofs, and Boolean Algebras (*)
**6.4** Russell's Paradox and the Halting Problem
**6.1 – 6.4** Exercises/Discussion

**II The Logic of Compound Statements (EPP Ch. 2.1 – 2.4; LLM Ch. 3.1 – 3.6)**

**2.1** Logical Form and Logical Equivalence
**2.2** Conditional Statements
**2.3** Valid and Invalid Arguments
**2.4** Application: Digital Circuits

**2.1 – 2.4** Exercises/Discussion

**III The Logic of Quantified Statements (Epp Ch. 3.1 – 3.4; LLM Ch. 3.5 – 3.6)**

**3.1** Predicates and Quantified Statements I
**3.2** Predicates and Quantified Statements II
**3.3** Statements with Multiple Quantifiers
**3.4** Arguments with Quantified Statements

**3.1 – 3.4** Exercises/Discussion

**IV Elementary Number Theory and Methods of Proof (EPP Ch. 4.1 – 4.7; LLM Ch. 9.1 – 9.2) (*)**

**4.1** Direct Proof and Counter Example I – IV
**4.2** Indirect Argument: Two Classical Theorems

**4.1 – 4.7** Exercises/Discussion

**V Sequences, Mathematical Induction and Recursion (Epp Ch. 4.1 – 4.7; LLM Ch. 5.1 – 5.3) (*)**

**5.1** Sequences
**5.2** Mathematical Induction I – II
**5.3** Strong Mathematical Induction
**5.4** Defining Sequences Recursively

**5.1 – 5.4** Exercises/Discussion

**VII Functions (EPP Ch. 7.1 – 7.4; LLM Ch. 4.1 – 4.5)**

**7.1** Functions Defined on General Sets
**7.2** One-to-One and Onto, Inverse Functions
**7.3** Composition of Functions
**7.4** Cardinality with Applications to Computability (*)

**7.1 – 7.4** Exercises/Discussion

**VIII Counting and Probability (EPP Ch. 9.1 – 9.7; LLM 15.1 – 15.9, 17.1 – 17.6 Ch.18 (*) )**

**8.1** Introduction
**8.2** Possibility Trees and the Multiplication Rule
**8.3** Counting Elements of Disjoint Sets: The addition Rule
**8.4** The Pigeonhole Principle
**8.5** Counting Subsets of a Set: Combinations
**8.6** r-Combinations with Repetition
**8.7** Pascal's Formula and Binomial Theorem

**8.1 – 8.7** Exercises/Discussion

**IX Graphs and Trees (EPP Ch. 10.1 – 10.3; LLM Ch. 10, Ch. 12)**

**9.1** Graphs: Definitions and Basic Properties
**9.2** Trails, Paths and Circuits
**9.3** Matrix Representation of Graphs (*)

**9.1 – 9.3** Exercises/Discussion

(*) Optional and/or time permitting

---

This is a fast-paced course that requires you to set aside adequate time for practice. **It is highly recommended** that you practice three or more times per week. Doing well in this course usually requires at least **6-10** hours per week of practice, depending on your current skill level. If you start to fall behind, for whatever reason, you should contact me as soon as possible to determine what can be done to rectify matters. Usually, something can be done to help you if you give me enough advance notice.

**HOMEWORK**

**Suggested Exercises:**

## EPP:

**Section 2.1**
**Core exercises**: 1, 3, 5a, 6, 8ad, 10ac, 12, 14, 16, 23, 25, 27, 32, 36, 38
**Exercises without solutions**: 5b-d, 10bde, 17, 26, 29, 39
**Section 2.2**
**Core exercises**: 1, 3, 5, 12, 13a, 16, 19, 20adf, 22adf, 23adf, 26, 32, 34, 37, 40, 42, 44,

46ab
**Exercises without solutions**: 8, 17, 20be, 21bc, 22be, 28, 35, 43
**Section 2.3**
**Core exercises**: 1, 3, 6, 7, 8, 12a, 22, 24-27, 36, 38a, 39
**Exercises without solutions**: 11, 30, 38bc, 40 (
**Section 2.5**
**Core exercises**: 1, 4, 7, 10, 13, 15, 17, 19, 38, 41, 44
**Exercises without solutions**: 2, 8, 14, 18, 40, 43, 47
**Section 1.1**
**Core exercises**: 1, 3, 5, 7ab, 8, 10, 12
**Exercises without solutions**: 9
**Section 3.1**
**Core exercises**: 1ab, 3, 5ac, 9, 11, 13, 14, 16ace, 17a, 18abe, 19, 21ac, 22a, 23a, 25ae, 27ab
**Exercises without solutions**: 12, 22b
**Section 3.2**
**Core exercises**: 1, 3ac, 4ac, 5a, 6a, 9, 11, 13, 15ac, 16, 18, 20, 22, 28, 39, 41
**Exercises without solutions**: 10, 12, 14
**Section 3.4**
**Core exercises**: 1bd, 2, 3, 5, 7-10, 16, 19ab, 21, 23, 28 (
**Exercises without solutions**: 6, 22, 24, 27, 29 (32 can be assigned for additional challenge)
**Section 4.1**
**Core exercises**: 1, 2a, 4, 11, 14, 19, 20, 22, 24, 25, 29, 33, 38, 39, 40, 43, 44, 45, 47
**Exercises without solutions**: 5, 12, 15, 21, 23, 27, 30, 34, 48, 49
**Section 4.2**
**Core exercises:** 1, 3, 4, 6, 8b, 11, 12, 13, 15, 35, 37
**Exercises without solutions**: 5, 10, 14, 16, 17, 18
**Section 4.6**
**Core exercises:** 1, 3, 5, 8, 9a, 11, 19, 21, 23, 30
**Exercises without solutions**: 9b, 14, 15, 20, 22
**Section 10.1**
**Core exercises:** 1, 3, 5, 8, 12, 15, 17, 18, 21, 24, 27a
**Exercises without solutions**: 13, 16, 19, 20, 22, 25, 27b
**Section 10.2**
**Core exercises:** 1, 4, 8a, 9a, 12, 14, 23, 26
**Exercises without solutions**: 8bcd, 9bc, 13, 25, 28, 29, 32, 33, 34, 35
**Section 10.3**
**Core exercises:** 2a, 3a, 4ac, 5a, 19a
**Exercises without solutions**: 2b, 3b, 4bd, 5b, 19bc
**Section 10.5**
**Core exercises:** 1a, 2a, 4a, 7a, 8, 9, 10, 11, 12, 13, 14, 22, 25
**Exercises without solutions**: 1b, 2b, 3, 4bcde, 5, 15, 16, 17, 18, 19, 20, 21, 23
**Section 10.6**
**Core exercises:** 1, 4, 5, 6, 7, 8, 9, 10, 11
**Exercises without solutions**: 2, 12, 13, 14, 15, 16, 17, 18, 19

**Section 1.2**
**Core exercises:** 1, 2ac, 3, 8a, 9abfi
**Exercises without solutions**: 4, 5, 6, 8bcd, 9cdeghj
**Section 6.1**
**Core exercises:** 1ace, 10abcde, 11, 14a, 15a, 17a
**Exercises without solutions**: 1bdf, 10fgh, 14b, 15bc, 17bcdef
**Section 1.3**
**Core exercises:** 1, 3, 5, 7, 9, 13, 15ab, 16
**Exercises without solutions**: 6, 15cde, 17
**Section 7.1**
**Core exercises:** 1, 4a, 8ab, 9abc, 13, 27a, 28a, 29a
**Exercises without solutions**: 4bc, 8cde, 9def, 14, 27b, 28b, 29b
**Section 4.4**:
**Core exercises**: 1, 3, 7
**Exercises without solutions**: 2, 4, 8, 9, 10
**Section 7.2**
**Core exercises:** 1, 2, ~~5,~~ 6, 7a, 9a, 16, 20
**Exercises without solutions**: 5, 7b, 9bcd
**Section 9.1**
**Core exercises:** 2, 3, 5, 7, 9, 11a, 11b(i) 12a, 12b(i), 18
**Exercises without solutions**: 4, 11b (ii, iii)
**Section 9.2**
**Core exercises:** 1, 3, 4, 6, 8, 9, 11ab, 12a, 13ab, 14abd, 22a, 34
**Exercises without solutions**: 11c, 12b, 13c, 15, 21, 22bc, 33
**Section 9.3**
**Core exercises:** 1, 3, 4, 6, 8a, 13, 16
**Exercises without solutions**: 2, 8bcd, 17
**Section 9.4**
**Core exercises:** 1, 3, 5, 10, 12, 29
**Exercises without solutions**: 2, 4, 6, 7, 11, 13
**Section 9.5**
**Core exercises:** 1, 3, 5ab, 6, 13ad, 15, 19
**Exercises without solutions**: 4, 5cdefg, 7, 8, 10, 13bce

## LLM:

3.1 – 3.4, 3.10, 3.14, 3.18, 3.21 – 3.25; 4.1 – 4.7, 4.29 – 4.39; 8.1 – 8.1 – 13; 9.3 – 9.12, 9.33 – 9.37; 10.1 – 10.30; 12.13 – 12.26; 15.1 – 15.30

**In addition, four sets of "Self-Tests"** will be given and will be discussed in class a week after assigned during regular problem sessions. However, **students are strongly urged to attempt problems by themselves and ask about or discuss (in class or in private) those they couldn't do.** Performance on self-test problems should be a reliable indication of your command of the subject.

**EXAMS**

There will be two in class time exams – a mid-term and the final – and one take-home exam. The grade will be calculated as follows: mid-term: 35%, "take-home": 15%, and final 50%. Because of the unique nature of the subject, in order to get full credit for exam problems, students have to show **ALL WORK IN DETAIL!** Make-up exams **will not be given.**

**Schedule of Exams:**

**MIDTERM: October 11, 5:30 – 9:00 pm, CST.**

Midterm exam will be accessible on D2L on October 11, at 5:30 pm and solutions have to be uploaded to D2L **Submission folder** on October 11, by 9:00 pm. **No late submissions will be accepted.**

**TAKEHOME: November 15, 9:00 pm – November 22, 5:00 pm, CST.**

Take-home exam will be accessible on D2L on November 15, at 9:00 pm and solutions have to be uploaded to D2L **Submission folder** by November 22, 5:00 pm, CST. **No late submissions will be accepted.**

**FINAL: November 22, 5:30 – 9:00 pm, CST.**

Final exam will be accessible on D2L on November 22 at 5:30 pm and solutions have to be uploaded to D2L **Submission folder** on November 22, by 9:00 pm, CST. **No late submissions will be accepted.**

**Grade scale:** 90-100% (A), 90-80% (B), 70-80% (C), 60-70% (D), below 60% (F)

---

**Course Policies**

**Changes to Syllabus**
This syllabus is subject to change as necessary during the quarter. If a change occurs, it will be thoroughly addressed during class, posted under Announcements in D2L and sent via email.

**Online Course Evaluations**
Evaluations are a way for students to provide valuable feedback regarding their instructor and the course. Detailed feedback will enable the instructor to continuously tailor

teaching methods and course content to meet the learning goals of the course and the academic needs of the students. They are a requirement of the course and are key to continue to provide you with the highest quality of teaching. The evaluations are anonymous; the instructor and administration do not track who entered what responses. A program is used to check if the student completed the evaluations, but the evaluation is completely separate from the student's identity. Since 100% participation is our goal, students are sent periodic reminders over three weeks. Students do not receive reminders once they complete the evaluation. Please see https://resources.depaul.edu/teaching-commons/teaching/Pages/online-teaching-evaluations.aspx for additional information.

**Academic Integrity and Plagiarism**
This course will be subject to the university's academic integrity policy.

All students are expected to abide by the University's Academic Integrity Policy, which prohibits cheating and other misconduct in student coursework. Publicly sharing or posting online any prior or current materials from this course (including exam questions or answers) is considered to be providing unauthorized assistance prohibited by the policy. Both students who share/post and students who access or use such materials are considered to be cheating under the Policy and will be subject to sanctions for violations of Academic Integrity.
In addition, violations of academic integrity include but are not limited to the following categories: cheating; plagiarism; fabrication; falsification or sabotage of research data; destruction or misuse of the university's academic resources; alteration or falsification of academic records; and academic misconduct. Conduct that is punishable under the Academic Integrity Policy could result in additional disciplinary actions by other university officials and possible civil or criminal prosecution. More information can be found at https://offices.depaul.edu/oaa/faculty-resources/teaching/academic-integrity/Pages/default.aspx.

**Academic Policies**
All students are required to manage their class schedules each term in accordance with the deadlines for enrolling and withdrawing as indicated in the University Academic Calendar. Information on enrollment, withdrawal, grading and incompletes can be found at: http://www.cdm.depaul.edu/Current%20Students/Pages/PoliciesandProcedures.aspx

**Incomplete Grades**
An incomplete grade is a special, temporary grade that may be assigned by an instructor when unforeseeable circumstances prevent a student from completing course requirements by the end of the term and when otherwise the student had a record of satisfactory progress in the course. All incomplete requests must be approved by the instructor of the course and a CDM Associate Dean. Only exceptions cases will receive such approval. Information about the Incomplete Grades policy can be found at http://www.cdm.depaul.edu/Current%20Students/Pages/Grading-Policies.aspx

**Students with Disabilities**
DePaul University is committed to ensuring equal access to its educational and extracurricular opportunities for students with disabilities. The Center for Students with Disabilities (CSD) offers reasonable academic accommodations and services to support our students. We also serve as a resource to the many university departments that have a responsibility to accommodate students.
Please see https://offices.depaul.edu/student-affairs/about/departments/Pages/csd.aspx for Services and Contact Information.

**Proctored exams for OL courses (if applicable)**
If you are an online learning student living in the Chicagoland area (within 30 miles of Chicago), you will need to come to one of DePaul's campuses to take an exam. Online learning students outside of the Chicagoland area are required to locate a proctor at a local library, college or university. You will need to take the exam within the window your instructor gives. Students should examine the course syllabus to find exam dates and the instructor's policy on make-up exams. Detailed information on proctored exams for online learning students can be found at
http://www.cdm.depaul.edu/onlinelearning/Pages/Exams.aspx