MT 399 DISCRETE MATHEMATICS
IES Abroad Madrid

COURSE DESCRIPTION:
The Foundations: Logic and Proofs
Basic Structures: Sets, Functions, Sequences, and Sums
Algorithms
Induction and Recursion
Counting Methods
Advanced Counting Techniques
Relations
Graphs
Trees

CREDITS: 4 credits

CONTACT HOURS: 60 hours

LANGUAGE OF INSTRUCTION: English

PREREQUISITES: Calculus sequence completed, Linear Algebra. Instructor's consent.

ADDITIONAL COST:

METHOD OF PRESENTATION:

REQUIRED WORK AND FORM OF ASSESSMENT:
The final grade for the course will consist of:

- Homework (10%): Homework will be assigned each week. No late homework will be accepted. Homework is due at the beginning of the lecture. The two lowest homework scores will be deleted for grading purposes.
- Class presentation (10%): Presentation an application of a topic in Discrete Mathematics to Engineering assigned by the instructor on the third week of class.
- Midterm exam (40%)
- Final exam (40%): The final exam is comprehensive and will include a bonus question worth 10/100 extra points that will allow the students to make up a low midterm score.

Course Element

LEARNING OUTCOMES:
On successful completion of the course, students should be able to:

- Analyze logical propositions using truth tables.
  Use mathematical induction to prove mathematical statements.
  Understand sets and perform operations and algebra on sets. Prove basic set equalities.
  Determine properties of relations, identify equivalence and partial order relations.
  Identify functions and determine their properties. Determine when a function is one-to-one and onto.
- Manipulate modular algebra.
- Formulate problems and solve recurrence relations.
  Define graphs, digraphs, and trees, and identify their main properties. Model problems using graphs and trees. Design and evaluate Euler and Hamilton circuits
  Evaluate combinations and permutations on sets. Apply counting principles to determine probabilities.
- Understand basic properties of Boolean Algebras.

ATTENDANCE POLICY:

As a member of our class community, you are expected to be present and on time every day. Attending class has an impact on your learning and academic success. For this reason, attendance is **mandatory for all IES Madrid classes**, including course-related excursions. Absences will only be excused in cases of documented medical or family emergencies. Any assessed work, including exams, tests, and presentations, will be rescheduled if the absence is justified; otherwise, it will be graded as 0. You are allowed a maximum of 1 unexcused absence for once-a-week courses and 2 unexcused absences for twice-a-week courses. Each additional absence will deduct 5 points from your final grade. **Accumulating 7 or more absences in twice-a-week courses, or 4 or more in once-a-week courses, may lead to a failing grade.** Students arriving more than 11 minutes after the scheduled start time will be marked as 'late.' Three 'late' arrivals will be counted as 1 absence. Any student arriving 30 minutes or more after the scheduled start time will be marked as 'absent.' For more information, please refer to the full Attendance and Punctuality Policy document.

CONTENT:

Session 1	Chapter 1: The Foundations: Logic and Proofs • Propositions, Compound Statements • Truth Tables • Logical Arguments • Methods of Proofs in Math Section 1.1-1.3 p. 12 – 15: 34-35	Exercises 2, 8, 12, 14, 16, 28, 34, 35 p. 12-15 Exercises 2, 6, 8, 12, 15, 16, 20, 24, 25 p. 34-35
Assignment 1: Sections 1.1 and 1.3.		
Session 2	Section 1.4, p. 53 – 54: Section 1.5, p. 64 – 67: Section 1.6 p. 78-80	Exercises 2, 6, 12, 14, 16, 19, 21 Exercises 2, 4, 20, 26 Exercises 1, 2, 21
Session 3	Chapter 2: Basic Structures: Sets, Functions, Sequences, and Sums • Operations - union, intersection, complement, difference • DeMorgan's Laws • Subsets, power sets, Venn diagrams • Equal vs. equivalent sets • Sets of numbers • Cartesian products • History - Cantor, Mandelbrot, Descartes, Venn Section 2.1, p. 125 – 126: Section 2.2, p. 136 – 137:	Exercises 2, 3, 5, 10, 16, 19, 21, 37 Exercises 1, 2, 4, 6, 7, 11, 20, 24, 35
Session 4	Section 2.3, p. 152 – 154:	Exercises 2, 3, 4, 7, 8, 10, 12, 13, 22, 33, 59
Assignment 2: Sections 1.4, 1.5, 1.6, 2.1, 2.2 and 2.3		

Session 6	Section 2.4, p. 167 – 169:	Exercises 4, 5, 9, 10, 13, 31, 33.
Session 7	Section 2.6, p. 183 – 185:	Exercises 3, 4, 9, 10, 16, 20, 24, 27.
Session 8	Chapter 3: Algorithms • Search algorithms • Optimization algorithms • Voting methods Section 3.1, p. 202 – 203:	Exercises 2, 5, 11,16.
Session 9	Section 3.3, p. 230 – 231:	Exercises 3, 5, 12, 16, 20.
Session 10	Chapter 5: Induction and Recursion • Mathematical Induction • Recursively Defined Sequences • Solving Recurrence Relations: Generating Functions Section 5.1, p. 329 – 330:	Exercises 4, 6, 7, 10, 13, 15, 20.
Assignment 3: Sections 2.4, 2.6, 3.1, 3.3 and 5.1		
Session 11	Section 5.3, p. 357 – 358:	Exercises 1, 2, 5, 7, 10, 24.
Session 10	Chapter 6: Counting Methods • Pigeonhole principle • Fundamental Theorem of Counting • Permutations • Combinations • Binomial Theorem. Pascal Triangle Section 6.3, p. 413 – 414: Section 6.4, p. 421 – 422:	Exercises 2, 4, 5, 7, 13. Exercises 3, 4, 5, 6, 10, 21, 23.
Session 11	Chapter 8: Advanced Counting Techniques • Pigeonhole principle • Fundamental Theorem of Counting • Permutations • Combinations • Binomial Theorem. Pascal Triangle Section 8.1 Applications of recurrence relations	Exercises 1, 2, 4, 5, 7, 16.a, 18. a.
Session 12	Section 8.2 Solving linear recurrence relations	Exercises 2, 4ag, 5, 7, 16,18, 26
Assignment 4: Sections 5.3, 6.3, 6.4, 8.1, 8.2		
Session 13	Section 8.3 Divide and conquer algorithms and recurrence relations	Exercises 2, 4, 6, 8.
Assignment 5: Section 8.3.		

Session 14	Chapter 9: Relations • Symmetry, transitivity, reflexivity • Equivalence classes • Congruence, partitions, domain, range, co-domain • One-to-one, onto, inverse • Modular numbers • History - Pythagorean relationship, Descartes Section 9.1, p.581 – 582:	Exercises 1, 3, 5, 8, 12, 21, 30
Session 15	Section 9.3, pgs.596 – 597:	Exercises 1, 3, 4,6, 8, 13, 15, 18, 22, 23.
Session 16	Section 9.5, p. 616	Exercises 18, 21, 22.
Assignment 6: Sections 9.1, 9.3, and 9.5		
Session 17	Chapter 10: Graphs • Euler and Hamiltonian networks • Graph coloring • Directed and undirected • Isomorphism • Traveling Salesperson problems • History - Euler, Hamilton, Bridges of Konigsberg Section 10.1, pgs. 649 – 650 Section 10. 2, pg. 665	Exercises 2, 3, 4, 6, 10, 11. Exercises 2, 3, 5, 6, 8, 15, 20, 22.
Session 18	Section 10.3, pgs. 675 – 676 Section 10.5, pgs. 703 – 704	Exercises 3, 5, 7, 10, 12, 26. Exercises 2, 3, 5, 8
Session 19	Section 10.6, pg. 716 Chapter 11 Trees • Introduction to Trees • Applications of Trees Section 11.1 p. 745	Exercises 2, 3, 4, 6, 7 Exercises 2, 3, 4, 11, 18
Session 20	Section 11.2 p. 765	Exercises 4, 6, 12, 20
Session 21	Section 12. 1 p. 789 Chapter 12 Boolean Algebra • Boolean Functions	Exercises 4, 5, 7, 12, 16
Session 22	Review session	

Assignment 7: Sections 10.1, 10.2, 10.3, 10.5, 10.6, 11.1, 11.2 and 12.1	
Session 23	FINAL EXAM: Sections covered from Chapters 1, 2, 3, 5, 7, 8, 9, 10, 11, 12 Final exam is comprehensive

REQUIRED READINGS:

- Discrete Mathematics and its applications by Rosen, 7th Edition. ISBN-13- 978-0073383095

RECOMMENDEND READINGS:

- Discrete Mathematics, an open introduction, by Oscar Levin. ISBN-13 -978-1516921188
- A Concrete introduction to Higher Algebra, Lindsay N. Childs. Undergraduate texts in Mathematics.ISBN-13-978-0387745275