10.4 SCS 1104 Discrete Mathematics I (3CU)

Course Description:

This course will develop advanced mathematics skills appropriate for students pursuing studies such as Engineering, Science, Computer Science, and Mathematics. Topics include sets, numbers, algorithms, logic, computer arithmetic, applied modern algebra, combinations, recursion principles, graph theory, trees, discrete probability, and digraphs

Course Objectives:

i. Demonstrate critical thinking, analytical reasoning, and problem solving skills
ii. Apply appropriate mathematical and statistical concepts and operations to interpret data and to solveproblems
iii. Identify a problem and analyze it in terms of its significant parts and the information needed to solve it
iv. Formulate and evaluate possible solutions to problems, and select and defend the chosen solutions
v. Construct graphs and charts, interpret them, and draw appropriate conclusions

Expected Learning Outcome:

i. Recognize, identify, and solve problems using set theory, elementary number theory, and discrete probability
ii. Recognize, identify, and apply the concepts of functions and relations and graph theory in problem solving
iii. Apply proof techniques in logic

Course Content:

- Introduction to the Peano Axioms and construction of the natural numbers, integer numbers, rational numbers, and real numbers.
- Construction and basic properties of monoids, groups, rings, fields, and vector spaces.
- Introduction to transfinite ordinals and transfinite cardinals, and Cantor's diagonalization methods

- Representation of large finite natural numbers using Knuth's "arrow notation"
- Introduction to first order propositional logic, logical equivalence, valid and invalid arguments
- Introduction to digital circuits
- Introduction to first order monadic predicate logic, universal and existential quantification, and predicate arguments
- Elementary number theory, prime factors, Euclid's algorithm
- Finite arithmetic, Galois Fields, and RSA encryption
- Proof techniques, including direct and indirect proofs, proving universal statements, proving existential statements, proof forms, common errors in proofs
- Sequences, definite and indefinite series, recursive sequences and series
- Developing and validating closed-form solutions for series
- Well ordering and mathematical induction
- Introduction to proving algorithm correctness
- Second order linear homogeneous recurrence relations with constant coefficients
- General recursivedefinitions and structural induction
- Introduction to classical (Cantor) set theory, Russell's Paradox, introduction to axiomatic set theory (Zermelo-Fraenkel with Axiom of Choice).
- Set-theoretic proofs
- Boolean algebras
- Halting Problem

Method of delivery:

Lectures, lab sessions completed in tutoring labs outside of lecture.

Methods of Assessment:

In-class exams that count for 40% of the student's course grade, homework assignments that account for 60% of the student's course grade.

Students are assessed on a combination of homework assignments, quizzes/tests, group activities, discussion, projects, and a comprehensive final exam.

Course textbooks and materials

i. Discrete Mathematics with Applicationsby Susanna S. Epp (Brooks-Cole/Cengage Learning).

ii. Discrete Mathematics by Sherwood Washburn, Thomas Marlowe, & Charles T. Ryan (Addison-Wesley)

Detailed Content

Item	Knowledge Unit	Topics Covered	Hours
1	Basic Analysis	Differences among best ,expected, and worst case behaviors Big-O, Big-Omega, Big-Theta definitions Complexity classes	10
2	Basic Logic	Propositional logic, connectives, truth tables, normal forms, validity, inference, predicate logical, quantification, limitations	10
3	Proof Techniques	Implications, equivalences, converse, inverse, contrapositive, negation, contradiction, structure, direct proofs, disproofs, natural number induction, structural induction, weak/string induction, recursion, wellorderings	10
4	Basics of Counting	Basic modular arithmetic	5
5	Sets, Relations, Functions	Sets only: Venn diagrams, union, intersection, complement, product, power sets, cardinality, proof techniques.	10
	Total Contact Hours		**45**