CPS204(2 UNITS)

DISCRETE STRCUTURES

INTRODUCTION TO DISCRETE STRUCTURES

Quick Overview

Why Discrete Structure:

The conceptual center of computer science is the **ALGORITHM**.

Discrete Math helps provide…

…the machinery necessary for creating sophisticated algorithms

…the tools for analyzing their efficiency

…the means of proving their validity

Quick Overview

Although the point of CPS204 is to provide the tools for creating and analyzing sophisticated algorithms, we won't focus on the algorithmic aspect, with some exceptions. You will see the algorithmic applications in CPS 307(Data Structures) when u get to 300 level Insha Allaah.

Quick Overview - Topics

- **Apply mathematical logic to prove properties of software**
  - Predicate calculus and natural deduction
  - Boolean algebra and equational reasoning
- **Understand fundamental data structures**
  - Sets
  - Functions and relations
- Additional topics
  - Graphs

Quick Overview - Topics

- Logic and Sets
  - Make notions you're already used to from programming a little more rigorous (operators)
  - Fundamental to all mathematical disciplines
  - Useful for digital circuits, hardware design

Quick Overview - Topics

- Graph Theory
  - Many clever data-structures for organizing information and making programs highly efficient are based on graph theory
  - Very useful in describing problems in
    - Databases
    - Operating Systems
    - Networks
    - EVERY CS DISCIPLINE!!!!

Course Learning Outcomes

Upon successful completion of this course, you will be able to:

- Create compound statements, expressed in mathematical symbols or in English, to determine the truth or falseness of compound statements and to use the rules of inference to prove a conclusion statement from hypothesis statements by applying the rules of propositional and predicate logic;
- Prove mathematical statements involving numbers by applying various proof methods, which are based on the rules of inference from logic;
- Define and identify the terms, rules, and properties of set theory and use these as tools to support problem solving and reasoning in applications of logic, functions, graphs and trees.
- Create graphs and trees to represent and help prove or disprove statements.

Course Requirements

- Attendance is compulsory for all registrants for the course.

- To be qualified to write the examination for the course, a minimum of 70% attendance must be obtained by a student.
- A midterm evaluation as part of the Continuous Assessment is mandatory.
- Assignments must be submitted online at scheduled dates.
- Every student is expected to participate in the online class activity such as lesson, assignment, chats etc.

COURSEWORK

- Class Participation(Class Attendance) 10%
- Assignments (Reading assignments and problem sets)
  - Approximately weekly 10%
- Continuous Assessment 20%
- Final Exam 60%

WEEKLY SCHEDULE OF LESSONS

WEEK II : Unit 1- Mathematical Logic.

- Logic is a language that captures the essence of our reasoning, and correct reasoning must follow the rules of this language. In logic, we are interested in true or false of statements, and how the truth/falsehood of a statement can be determined from other statements. However, instead of dealing with individual specific statements, we are going to use symbols to represent arbitrary statements so that the results can be used in many similar but different cases.
- We are going to be concerned with propositional logic and predicate logic, which are fundamental to all types of logic.
- In this unit, we will examine various rules of logic (i.e. negations, conjunctions, and disjunctions) in order to determine how they can create conditional statements, arguments, and rules but also prove the truthfulness or falseness of any argument, whether presented in mathematical terms or in everyday language.

WEEK III: UNIT 2 -PROPOSITIONAL EQUIVALENCES

- We start propositional equivalences in week II. Two logical expressions are said to be equivalent if they have the same truth value in all cases. Sometimes this fact helps in proving a mathematical result by replacing one expression with another equivalent expression, without changing the truth value of the original compound proposition. This has been applied to prove the properties of software. Our goal will be to learn how to determine the validity or falsity of a mathematical statement via methods of logical equivalencies. Future mathematical arguments can be proved or disproved using these methods.
- In this unit, we will be learning tautologies, contradictions, logical equivalencies, and derivational proof techniques.

WEEK IV & V: UNIT 3-PREDICATE LOGIC

- In this unit, we learn a little more powerful logic called predicate logic. It allows us to reason with statements involving variables among other. The propositional logic is not powerful enough to represent all types of assertions that are used in computer science and mathematics, or to express certain types of relationship between propositions such as equivalence Also the pattern involved in logical equivalence cannot be captured by propositional logic.
- What to be learn are predicates, universe of discourse, quantifiers, illegal quantification, multivariate quantification, parsing multivariate quantification, how to read quantified formulas, and order of application of quantifiers.

WEEK V & VI: UNIT 4-SET THEORY

- The concept of set is a fundamental tool to mathematics and computer science. It is known as the starting point for mathematical study. In other words, everything mathematical starts with sets. For example, relationships between two objects are represented as a set of ordered pairs of objects, the concept of ordered pair is defined using sets, natural numbers, which are the basis of other numbers, are also defined using sets. The concept of function, being a special type of relation, is based on sets, and graphs and digraphs consisting of lines and points are described as an ordered pair of sets. In this unit, we will be learning about representation of set, basics of set such as equality of sets; proper set; universal set etc., and mathematical reasoning with set.

WEEK VII: MID-SEMESTER ASSESSMENT

- Students will be examined in the areas that have so far been covered in the Semester. This will afford students an opportunity of a revision of all topics that have already been taken.

WEEK VIII & IX: UNIT 5(RELATIONS)

- The relation we are going to study here is an abstraction of relations we see in our everyday life such as those between parent and child, students and department, car and owner, address and telephone number etc. An application area of relation in that sense is database management systems. Along with hierarchical and network models of data, the relational model is widely used to represent data in a database.
- The subjects to be covered in this unit include binary relations, equivalence relations, definition of binary relations and properties, special relations among others. Completing this unit will take approximately 2 weeks.

WEEK X: UNIT 6 (FUNCTIONS)

- A function is something that associates each element of a set with an element of another set. The concept of function appears quite often even in nontechnical contexts. For example, the grade for a course is often determined by test and exam scores, assignments and projects, a personal identification number (PIN) uniquely identifies the person, the income tax rate for an employee varies depending on the income, and so on. In this unit, we will be learning about definition of functions, domain and codomain, images, composite functions and so on.

WEEK XI & XII: UNIT 7 (GRAPHS & TREES)

- A graph is a bunch of vertices (or nodes) represented by circles which are connected by edges, represented by line segments. Mathematically, graphs are binary-relations on their vertex set. They serve innumerable purposes: they can represent communications systems, chart knowledge, and even solve problems. In this unit, we will acquaint ourselves with special kinds of mathematical graphs while discussing graph concepts from degree and vertex. We will then turn to trees, which comprise a special category of graphs, as they serve special purposes and have different structures. Trees and graphs have application to artificial intelligence, scheduling problems, and transportation systems.

WEEK XIII: REVISION WEEK

- In this week, Students will be taken through the summary of all the topics that have so far been covered in the Semester. This will afford an opportunity of a revision of all topics that have already been taken.

COURSE MATERIALS

- The primary learning materials for this course are readings, lectures (in powerpoint slides), video tutorials(the links are given), and other online resources.
- These course materials can be downloaded on the LMS platform.

Recommended texts for further reading

- Mathematical Structures for Computer Science by Judith L. Gersting, Seventh edition.
- Concrete mathematics: A foundation for computer science by Donald Knuth, Second edition.
- Discrete mathematics and its applications by Kenneth Resen.