DISCRETE MATHEMATICS II

1.Thông tin về học phần (General Information)

Tên học phần (Course name): Discrete Mathematics 2

Mã học phần (Course code): INT1359

Số tín chỉ (Number of credits): 3

Loại học phần (Course type): Compulsory

Học phần tiên quyết (Prerequisites):

- Introduction to Computing and Programming

Học phần trước (Previous courses):

Học phần song hành (Parallel courses):

Các yêu cầu đối với học phần (Course requirements):

- Lecture room: Projector, microphone and speaker, black board or white board
- Laboratory:

Giờ tín chỉ đối với các hoạt động (Teaching and Learning hours):

- Lý thuyết (Lectures): 36h
- Bài tập (Exercises): 8h
- Bài tập lớn (Projects): 0h
- Thực hành (Labs): 0h
- Tự học (Individual reading): 1h

Địa chỉ Khoa/Bộ môn phụ trách học phần (Address of the Faculty/Department in charge of the course):

- Address: Faculty of Information Technology 1 - Posts and Telecommunications Institute of Technology, Km10, Nguyen Trai Street, Ha Dong District, Hanoi.
- Phone number: (024) 33510432

2. Mục tiêu học phần (Objectives)

Về kiến thức (Knowledge):

The goal of this course is to introduce students to ideas and techniques from advanced topics of discrete mathematics that are widely used in science and engineering. This course teaches the students techniques in how to think logically and mathematically and apply these techniques in solving graph-related problems. To achieve this goal, students will learn:

- basic definitions of graphs.
- searching algorithms based on graphs structures.
- special graphs such as Euler graphs and Hamilton graphs and their applications.
- how to build a spanning tree from a graph.
- how to find the shortest paths within the graphs.
- how to build the maximum network flow via graphs.

Kỹ năng (Skills):

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

- think logically and mathematically and apply these techniques in solving graph-related problems
- know standard graph-based algorithms that are widely used in computer science.
- develop efficient algorithms to solve practical problems of graph-related applications.

Thái độ, Chuyên cần (Attitude):

Students are required to attend the classes and complete course exercises and assignments.

3. Tóm tắt nội dung học phần (Description)

This course introduces students to advanced topics of discrete mathematics and their applications in computer science and engineering. Studying topics include graph structures and their related algorithms to solve practical problems such as how to find the shortest route that links any two nodes in a graph; how to quickly search a special node in a graph; or how to design an optimized network flow via a network. In particular, students will learn a graph model and its representations in computer programming; different approaches to develop efficient algorithms based on graphs and to handle special graphs such as Euler and Hamilton graphs; and how to build spanning trees and the maximum network flow via a network.

4. Nội dung chi tiết học phần (Outlines)

Chapter 1: Graph terminology and representation

1.1. Graph definition
    1.1.1. Graph definition
    1.1.2. Undirected graph
    1.1.3. Directed graph
    1.1.4. Single graph
    1.1.5. Multiple graph
1.2. Basic terminology
    1.2.1. Undirected graph
    1.2.2. Directed graph
1.3. Graph Types
    1.3.1. Complete graph
    1.3.2. Star graph
    1.3.3. Bipartite graph
    1.3.4. Other special graphs
1.4. Graph representations
    1.4.1. Adjacency matrix
    1.4.2. Incidence matrix
    1.4.3. Edge list
    1.4.4. Adjacency list
1.5. Case study

Chapter 2: Searching algorithms on graphs

2.1. Depth-first search algorithm
    2.1.1. Introduction
    2.1.2. Pseudo code
    2.1.3. Example
2.2. Breath-first search algorithm
    2.1.1. Introduction
    2.1.2. Pseudo code
    2.1.3. Example
2.3. Application of search algorithms

2.3.1. Listing all vertices of a graph
2.3.2. Determine the number of connected graph components
2.3.3. Finding a path between two vertices of a graph
2.3.4. Listing bridges in a graph
2.3.5. Listing cut vertices in a graph
2.3.6. Strong connectivity of a graph
2.3.7. Weak connectivity of a graph
2.3.8. Others
2.4. Case study
2.4.1. Difference between DFS and BFS algorithms
2.4.2. Several practical problems that can solved by graph searching algorithms

Chapter 3: Eulerian and Hamiltonian Graphs
3.1. Definition
3.1.1. Eulerian and semi-Eulerian graphs
3.1.2. Hamiltonian and semi-Hamiltonian graphs
3.2. Euler circuit and Euler path
3.2.1. Finding a Eulerian circuit
3.2.2. Finding a Eulerian path
3.3. Hamiltonian circuit and Hamiltonian path
3.2.1. Finding a Hamiltonian circuit
3.2.2. Finding a Hamiltonian path
3.4. Case study

Chapter 4: Trees and spanning trees
4.1. Basic definition
4.1.1. Tree and properties
4.1.2. Spanning tree
4.2. Building spanning tree
4.2.1. Using DFS
4.2.2. Using BFS
4.2.3. Examples
4.3. Building the minimum spanning tree
4.3.1. Kruskal algorithm
4.3.2. Prim algorithm
4.3.3. Examples
4.4. Case study

Chapter 5: The shortest path problem
5.1. Problem statement
5.2. Dijkstra algorithm
5.2.1. Introduction
5.2.2. Pseudo code
5.2.3. Implementation example
5.3. Bellman-Ford algorithm
5.3.1. Introduction
5.3.2. Pseudo code
5.3.3. Example
5.4. Floyd algorithm
5.4.1. Introduction
5.4.2. Pseudo code
5.4.3. Example
5.5. Case study

Chapter 6: Maximum network flow problem
6.1. Problem statement
6.2. Max-flow min-cut theorem
6.3. Ford-Fulkerson
6.4. Case study

5. Học liệu (Textbooks)

5.1. Học liệu bắt buộc (Required Textbooks)

[1] Rosen, Kenneth H.. *Discrete Mathematics and its Applications*. 8th edition, McGraw Hill, 2018.

5.2. Học liệu tham khảo (Optional Textbooks)

[2] Susanna S. Epp, Discrete Mathematics with Applications. 5th edition, Cengage Learning, 2019

[3] Oscar Levin, Discrete Mathematics: An Open Introduction, 3rd Edition, 2019

6. Phương pháp, hình thức kiểm tra – đánh giá kết quả học tập học phần (Grading Policy)

Grading method	Percentage	Group/Individual
- Attendance	10%	Individual
- Exercises	10%	Individual
- Mid-term exams	10%	Individual
- Final examination	70%	Individual

Trưởng Bộ môn
(Head of Department)

Ngô Xuân Bách

Giảng viên biên soạn
(Lecturer)

Nguyễn Văn Thuỷ