	VIETNAM NATIONAL UNIVERSITY OF HO CHI MINH CITY UNIVERSITY OF NATURAL SCIENCES **FACULTY OF INFORMATION TECHNOLOGY**

COURSE SYLLABUS

Course Code: TH114

Title: Graph Theory

Credits: 4

Workload:
Lecture hours: **3** periods * **15** weeks = **45** periods
Laboratory hours: **2** periods * **15** weeks = **30** periods
Preparative hours: **2** periods * **15** weeks = **30** periods

Prerequisites: Discrete mathematics
TH012 - Intermediate Programming A2

Course Objectives:

The aim of this course is to provide students with fundamental concepts in graph theory, and to presents to them intermediate material on the design and analysis of graph algorithms and their applications.

Main Text: N/A

References:

- Berge, C., 1967, *Théorie des Graphes et ses Applications*, Duno Paris.
- Berge, C., 1970, *Graphes et Hypergraphes*, Dunod Paris.
- Nicos Christofides, 1975, *Graph Theory: An Algorithmic Approach*, New York: Academic.
- Gary Chartrand, 1993, Ortrud R. Oellermann, *Applied and Algorithmic Graph Theory*, New York : McGraw-Hill.
- Kenneth H. Rosen, 1999, *Discrete Mathematics and Its Applications*, McGraw-Hill.
- Robin J Wilson, 1996, *Introduction to Graph Theory*, London : Longman.

Course Outline:

Chapter 1 Graph Fundamentals

1.1 Definitions
- 1.1.1 Directed graph (digraphs)
- 1.1.2 Undirected graph
- 1.1.3 Loops, parallel edges, cut vertices, pendant vertices, and isolated vertices

1.2 Types of Graphs
- 1.2.1 Multi Graphs and Simple Graphs.
- 1.2.2 Complete (undirected) Graph K_n
  - 1.2.2.1 Bipartite Graphs, and Complete Bipartite Graphs $K_{m,n}$
  - 1.2.2.2 Complements of undirected graphs

1.3 Degree of a vertex

1.3.1 Degree
1.3.2 In-Degree
1.3.3 Out-Degree
1.3.4 The relationship between the degrees of vertices and the number of edges.
1.4 Isomorphism, Subgraphs, and Induced (Generated) Subgraphs
1.4.1 Isomorphic Undirected Graphs
1.4.2 Isomorphic Digraphs
1.4.3 Subgraphs, and Induced (Generated) Subgraphs
1.5 Paths, cycles, and cocycles
1.5.1 Chains, simple chains
1.5.2 Paths in undirected/directed graphs
1.5.3 Cycles
1.5.4 Circuits (in directed graphs)
1.5.5 Cocycles (Cut-sets)
1.6 Connectivity of a graph
1.6.1 Connected components
1.6.2 Algorithms of finding connected components.
1.6.3 Connected graphs
1.6.4 Cut vertexes
1.6.5 Edge and Vertex Connectivity
1.6.6 Relationship between Edge Connectivity, Vertex Connectivity and Degrees of Vertices
1.6.7 Strongly Connected Graphs
1.7 Matrix representation of Graphs
1.7.1 Adjacency Matrices of Undirected Graphs A(G).
1.7.2 Adjacency Matrices of Directed Graphs A(G).
1.7.3 Adjacency Matrices B (G).

Chapter 2 Trees

2.1 Definitions
2.1.1 Definition of Trees
2.1.2 Definition of Forests
2.2 Theorems
2.2.1 Definition Equivalence
2.2.2 Theorem: Each tree must have at least two pendant vertices
2.3 Spanning Trees
2.3.1 Definition
2.3.2 Theorem of the existence of spanning tree
2.3.3 Algorithm to find spanning trees
2.3.4 Minimal Spanning Trees
2.3.5 The Prim’s Algorithm
2.3.6 The Kruskal’s Algorithm
2.4 Arborescence (Out trees)
2.4.1 Rooted Trees
2.4.2 Pseudo Strongly Connected Graphs
2.4.3 Theorem (Rooted Graphs <=> Pseudo Strongly Connected Graphs; Pseudo Strongly Connected Graphs => Connectivity).
2.4.4 Arborescence (Out trees)
2.4.5 The theorem of equivalent conditions
2.4.6 The theorem of the existence of out tree

Chapter 3 Planar Graphs and Graph Coloring

- 3.1 Definitions
  - 3.1.1 Planar Graphs
  - 3.1.2 Homeomorphic Graphs
- 3.2 Series Reduction
  - 3.2.1 Series Reduction
  - 3.2.2 Theorem of Series Reductions
- 3.3 Euler’s Formula, Lemmas and Applications
  - 3.3.1 Euler’s Formula.
  - 3.3.2 The Necessary Conditions of a Planar Graph
- 3.4 Kuratowski's Theorem
  - 3.4.1 K5 is non-planar
  - 3.4.2 K3,3 is non-planar
  - 3.4.3 Kuratowski's Theorem
- 3.5 Graph coloring problem
  - 3.5.1 Chromatic number
  - 3.5.2 Properties of Chromatic number
  - 3.5.3 The History of The Four Color Problem
  - 3.5.4 The Five Color Theorem
  - 3.5.5 The Four Color Problem

Chapter 4 Paths

- 4.1 Shortest Paths
  - 4.1.1 Problem Statement
  - 4.1.2 Condition of the Existence of Shortest Paths
- 4.2 Shortest Path Algorithms
  - 4.2.1 Dijkstra’s Shortest Path Algorithm
  - 4.2.2 Floyd’s Shortest Path Algorithm
  - 4.2.3 Bellman’s Shortest Path Algorithm
- 4.3 Eulerian Graphs
  - 4.3.1 Historical Context
  - 4.3.2 Definitions
  - 4.3.3 Euler’s Theorems for Undirected Graphs (The necessary and sufficient conditions for undirected graphs to be Eulerian graphs)
  - 4.3.4 Euler’s Theorems for Directed Graphs (The necessary and sufficient conditions for directed graphs to be Eulerian graphs)
- 4.4 Hamiltonian Graphs
  - 4.4.1 Historical Context
  - 4.4.2 Definitions
  - 4.4.3 Theorems about Hamiltonian Graphs
  - 4.4.4 An algorithm to find Hamiltonian paths or cycles

Chapter 5 Miscellaneous

Grading Final exam : 70%

Assignments: 30%