MMAT5380 **Graph Theory and Networks**

Course Description: This course is designed for the M.Sc. Degree programme. This course covers some fundamental concepts and principles of graph theory and networks. Transferring some big-data problems to graph models will be introduced. In order to solve such problems, some algorithms of graphs and networks are also discussed. Some classical problems are also introduced, such as Four Color Problem, Chinese Postman Problem and Traveling Salesman Problem.

No prior knowledge is assumed.

Learning outcomes
Upon completion the course, students will be able to
1. Describe the basic concepts, terminologies and properties of graphs.
2. Apply graph algorithms to solve related real life problems.

Course syllabus:
1. Basic concepts and terminologies of graphs and networks
2. Social Network – Centrality and Cliques, Degree of Closeness
3. Ranking Data
4. Shortest Path Algorithm – An application on Social Network
5. Timetabling using Coloring
6. Chinese Postman Problem and Traveling Salesman Problem

Textbook:
W.C. Shiu and P.K. Sun, *A First Course in Graph Theory*, Department of Mathematics, Hong Kong Baptist University, 2014.

References:

1 J.A. Bondy and U.S.R. Murty, *Graph Theory with Applications*, Macmillan, 1976.
2 G. Chartrand and L. Lesniak, *Graphs & Digraphs*, 3rd Ed., Chapman & Hall, 1996.
3 J. Clark and D.A. Holton, *A First Look at Graph Theory*, World Scientific, 1996.
4 J.A. McHugh, *Algorithmic Graph Theory,* Prentice-Hall, 1990.
5 D.B. West, *Introduction to Graph Theory*, Prentice-Hall, 1996
6 R.J. Wilson and J.J. Watkins, *Graphs, An Introductory Approach*, John Wiley and Son, 1990.
7 邵慰慈，潘建強：基礎離散數學，九章出版社，2005.

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Detail Content in Outline:

I. Graphs and Networks
   A. Big data problems – graph models
   B. Definitions and basic properties
   C. Representation of graph by matrices
   D. Subgraphs and graph operations
   E. Connectivity

II. Centralities in Social Networks
   A. Degree centrality, betweenness centrality, closeness centrality
   B. Ranking data: Eigenvector centrality and Google page rank

III. Trees
   A. Properties of trees
   B. Spanning tree of a graph
   C. Minimal spanning trees and algorithms

IV. Eulerian and Hamitonian Graphs
   A. Chinese Postman Problem
   B. Traveling Salesman Problem

V. Graph Colorings
   A. Vertex coloring and algorithms
   B. Plane graphs and Euler's formula
   C. Map coloring five color theorem
   D. Chromatic polynomial
   E. Edge coloring and timetabling

VI. Graph Algorithms
   A. Dijkstra's shortest path algorithm
   B. Graph coloring algorithm