MA860 **Algorithmic Graph Theory** **4 0 0 4**

Objectives: The main objective of the course is for students to learn some classical theorems and algorithms in the field. It is expected that students will be able to demonstrate their knowledge of algorithms by solving concrete problems. In addition, students will learn some proofs of the discussed theorems and prove simple facts about graphs and graph algorithms

Typical topics include:

- Computational complexity. Definitions of the complexity classes P, NP, and NP-hard. polynomial reductions, 2-SAT problem, 3-SAT problem.
- Tree search in graphs and digraphs. Breadth-first search and depth-first search
- Introduction to graphs: undirected graphs, directed graphs, weighted graphs, graph representation and special classes of graphs (trees, planar graphs etc.).

- Algorithmic problems on graphs: minimum spanning trees, shortest path problems, matching problems.
- Planar graphs and their properties. Eular's formula, planar separateor theorem and their algorithmic applications.
- Optimization problems on graphs including graph colouring and graph questions in distributed systems. Matching and maximal matching algorithms. Approximation algorithm for vertex cover problem. Approximation algorithms for the metric traveling salesman problem.
- Discussing practical applications of graphs and efficient algorithms for such practical problems. Approximation algorithms and heuristic algorithms. Applications to searching in massive graphs (e.g. page ranking); use of structural properties and algebraic properties.
- Further examples of tractable problems. Polynomial time algorithm for the maximum cut problem in planar graphs. Polynomial time algorithm for the 3-coloring problem on graphs with small dominating sets. The independent set problem: Matching techniques. Method of augmenting graphs. Decomposition by clique separators. Modular decomposition. Bounded tree-width, bounded clique-width. Applications of these methods, both individually and combined.

Text / Reference books:

1.Algorithmic Graph Theory, Alan Gibbons.

2.Introduction to Algorithms, Cormen, Leiserson, Rivest.

3. M. C. Golumbic. Algorithmic Graph Theory and Perfect Graphs, Volume 57 in the series Annals of Discrete Mathematics. North Holland, second edition, 2004.

4. M. R. Garey, D. S. Johnson, Computers and Intractability: A guide to the theory of NPCompleteness, 1979.

5. Introduction to Graph Theory, Douglas B. West, 2nd Ed.