

Matching and Covers: Matchings, maximal and maximum matchings, M-augmenting paths, Hall's theorem and consequences, Min-max theorems, maximum matchings and vertex covers, independent sets and edge covers, Connectivity, vertex cuts, Edge-connectivity.

Connectivity and Paths: Blocks, k-connected graphs, Menger's theorem, line graphs, network flow problems, flows and source/sink cuts, Ford-Fulkerson algorithm, Max-flow min-cut theorem.

Graph Coloring: Vertex colorings, bounds on chromatic numbers, Chromatic numbers of graphs constructed from smaller graphs, chromatic polynomials, properties of the chromatic polynomial, the deletion-contraction recurrence.

Planar Graphs: Planar graphs, Euler's formula, Kuratowski's theorem, five and four color theorems.

Readings:

1. Douglas B West, "Introduction to Graph Theory", II Edition, 2017, Pearson.
2. Gary Chartrand and Ping Zhang "Introduction to Graph Theory", 2017, Tata McGraw Hill.
3. Jonathan L. Gross and Jay Yellen, "Graph Theory and Its Applications", 2nd Edition, 2005, Chapman Hall (CRC).
4. The course will also be taught through various research Courses.

MCSE303: NETWORK SCIENCE

Course Objectives: The course aims to acquaint the students with the graph theory concepts relevant for network science. The students learn dynamics of and on networks in the context of applications from disciplines like biology, sociology, and economics

Course Learning Outcomes :

At the end of the course, the student will be

CO1: able to appreciate ubiquity of graph data model

CO2: able to understand the importance of graph theoretic concepts in social network analysis

CO3: able to understand the structural features of a network

CO4: familiar with the theoretical graph generation models

CO5: identify community structures in networks

CO6: able to write programs to solve complex network problems

Syllabus:

Introduction: Introduction to complex systems and networks, modelling of complex systems, review of graph theory.

Network properties: Clustering coefficient, centrality measures for directed and undirected networks.

Graph models: Random graph model, Small world graph model, Network evolution using preferential attachment

Community structure in networks: Communities and community detection in networks, Hierarchical algorithms for community detection, Modularity based community detection algorithms, Label Propagation algorithm

Readings:

1. Mohammed J. Zaki, Wagner Meira Jr.; Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014
2. Albert Barabasi, Network Science , Cambridge University Press, 2016
3. M.E. J. Newman, Networks: An Introduction, , Oxford University Press, 2010.
4. [David Easley](#) and [Jon Kleinberg](#), Networks, Crowds, and Markets: Reasoning About a Highly Connected World, Cambridge University Press, 2010

MCSE 304: INFORMATION RETRIEVAL [3-0-1]

Course Objectives: This course aims to equip the students with basic techniques for information retrieval that find use in text analytics. The student will also learn to apply the tools for information extraction.

Course Learning Outcomes:

On completion of the course, the student will be able to

CO1: describe early developments in IR.

CO2: apply measures for evaluating retrieved information.

CO3: choose appropriate model for document processing.

CO4: develop simple information retrieval tools to solve real world problems.

Syllabus:

Unit 1- Introduction: Information, Information Need and Relevance; The IR System; Early developments in IR, User Interfaces.

Unit 2- Retrieval and IR Models: Boolean Retrieval; Term Vocabulary and Postings list; Index Construction; Ranked and other alternative Retrieval Models.

Unit 3- Retrieval Evaluation: Notion of Precision and Recall; Precision-Recall Curve, Standard Performance Measures such as MAP, Reciprocal ranks, F-measure, NDCG, Rank Correlation.

Unit 4- Document Processing: Representation; Vector Space Model; Feature Selection; Stop Words; Stemming; Notion of Document Similarity; Standard Datasets..

Unit 5- Classification and Clustering: Notion of Supervised and Unsupervised Algorithms; Naive Bayes, Nearest Neighbour and Rocchio's algorithms for Text Classification; Clustering Methods such as K-Means.