

0205510 GRAPH THEORY

Normal Education

Evening Education

Spring 2018-2019

**Course Format:** face-to-face

**INSTRUCTOR INFORMATION**

**Instructor:**

**Title:**

**Office:**

**Phone:**

**Office Hours:**

**E-mail:**

**COURSE DESCRIPTION**

**Credit hours:** *3 credits (3+0)*

**ECTS**: *5*

**Required or elective:** *Technical* *elective for Computer Engineering Students*

**Catalog Description:**  *This course will cover the fundamental concepts of Graph Theory: simple graphs, digraphs, Eulerian and Hamiltonian graphs, trees, matchings, networks, paths and cycles, graph colorings, and planar graphs. Famous problems in Graph Theory include: The Network Flow Problem (maximizing flow in a network), the Four Color Problem (coloring maps with four colors so that adjacent regions have different colors), and the Traveling Salesman Problem (visiting n cities with minimum cost) etc.*

**Prerequisites:** *-*

**Textbook(s) and/or required materials:** *Modern Graph Theory - Bela Bollobas, Springer-Verlag, ISBN: 0 387 98488-7*

*Introduction to Graph Theory, D. West, Prentice Hall, ISBN: 0 13 014400 2*

**Course Objectives**

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| ***The objectives of this course are to:*** | |
| *1* | *Engage in the mathematical process: question, experiment, conjecture, prove, critique* |
| *2* | *Construct graph models in applied contexts (e.g., scheduling, routing, and assignment).* |
| *3* | *Recognize and apply common algorithmic principles (e.g., recursive or greedy)* |
| *4* | *Select/apply appropriate algorithms or theorems to solve existence, counting, and*  *optimization problems.* |

**Course Topics**

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| --- | --- |
| ***No*** | ***Topics*** |
| *1* | *Introduction to Graph Theory. Definitions, examples of problems in graph theory.* |
| *2* | *Adjacency and incidence matrices, isomorphisms. Paths, walks, cycles, components, cut-edges, cut-vertices. Bipartite graphs, Eulerian graphs* |
| *3* | *Vertex degrees, reconstruction conjecture. Degree sequences.* |
| *4* | *Directed graphs, de Bruijn cycles. Orientations and tournaments. Trees and forests, characterizations of trees.* |
| *5* | *Spanning trees, radius and diameter. Enumeration of trees, Cayley’s formula, Prüfer code.* |
| *6* | *Counting spanning trees, deletion-contraction, the matrix tree theorem, graceful labelings.*  *Minimum spanning trees (Kruskal’s algorithm), shortest paths (Dijkstra’s algorithm). Matchings, maximal and maximum matchings, M-augmenting paths.* |
| *7* | *Hall's theorem and consequences. Min-max theorems, maximum matchings and vertex covers, independent sets and edge covers. Independent sets and edge covers. Connectivity, vertex cuts.* |
| *8* | *Midterm Exam* |
| *9* | *Edge-connectivity, blocks, k-connected graphs. Menger’s theorem, line graphs.* |
| *10* | *Network flow problems, flows and source/sink,* *Ford-Fulkerson algorithm, Max-flow min-cut theorem* |
| *11* | *Vertex colorings, bounds on chromatic numbers.* |
| *12* | *Chromatic numbers of graphs constructed from smaller graphs, chromatic polynomials.* |
| *13* | *Properties of the chromatic polynomial, the deletion-contraction recurrence. Planar graphs, Euler's formula,* |
| *14* | *Kuratowski's theorem, five and four-color theorems. Graph Problems in Computer Engineering* |

**Course Learning Outcomes**

*At the end of the course students;*

* *be able to appreciates the basics & definition of a combinatorial Graph*
* *be able to grasp features, properties of special graphs.*
* *learns graph algorithms and its applications into computer science and computer problem solving etc.*
* *be able to formulate and prove central theorems about trees, matching, connectivity, coloring and planar graphs;*
* *be able to appreciate the significance of graph as a versatile modeling entity which can be used for analysis as well as synthesis, wireless communication protocols & system design, computer problem solving, data structures etc.*

**Evaluation methods**

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| --- | --- |
| *1. Midterm Exam* | 40% |
| *2. Final Exam* | 60% |

**Professional component**

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| --- | --- |
| *Engineering topics* | 50% |
| *General education* | 0% |
| *Mathematics and basic sciences* | 50% |

**Person(s) who prepared this description and date of preparation**

*Enes Ayan, April 2018*

**Date of last revision**

*April 2018*