King Fahd University of Petroleum and Minerals

Department of Information and Computer Science

ICS 553-01: Design and Theory of Algorithms

Term: 241

INSTRUCTOR: Sultan Almuhammadi
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COURSE SITE: almuhammadi.com/sultan/ics553 and Blackboard

DESCRIPTION

Review of RAM model of computation, complexity measures of time and space. Graph Algorithms for minimum spanning trees, shortest paths, matroids, the planar separator theorem. Planarity and planarization. Network flow algorithms. Graph matching and coloring. Establishing lower bounds. NP Completeness: Cook' s theorem. Various complexity classes and their relationships. Techniques for establishing completeness. Approximation and probabilistic algorithms to NP-hard problems.

PREREQUISITES ICS 353 or Equivalent

TEXTBOOK

M. Alsuwaiyel, *Introduction to Algorithms: Design Techniques and Analysis*, World Scientific Publishing Co., Inc. (2016)

OTHER REFERENCES

1. T. Cormen, C. Leiserson, R. Rivest & C. Stein "Introduction to Algorithms", 2nd Edition, The MIT Press, 2001.
2. Handouts and Lecture Notes (See Course Website).

LEARNING OUTCOMES

After taking this course, the student shall be able to

1. Analyze the complexity of iterative and recursive algorithms.
2. Explain and prove NP Completeness.
3. Comprehend and apply various approaches to solving hard problems, such as backtracking and branch-and-bound, approximation algorithms and/or randomized algorithms.
4. Describe and analyze algorithmic techniques that are based on iterative improvement for problems like network flow and graph matching.

EVALUATION

Homework Assignments	10 %
Quizzes	10 %
Active Learning and Participation	15 %
Project/Term Paper	15 %
Midterm Exam	20 %
Final Exam	30 %

CONTENTS (TENTATIVE)

1. Review on Searching and Sorting Algorithms, Complexity Analysis and Recurrence Relations.
2. NP-Completeness: Definitions of the classes P, NP, co-NP, Polynomial-time reductions.
3. Computational Complexity: Turing machines, Time and space classes, Compression and Linear speed-up, Time and space complexity hierarchy.
4. Lower bounds: Lower bounds for sorting, Algebraic decision tree model, Linear-time reduction.
5. Backtracking, Branch and bound.
6. Randomized Algorithms: Randomized Quicksort, Sampling, Pattern Matching, Randomized Selection, Primality Test, Zero-knowledge Proofs.
7. Approximation Algorithms: Bin Packing, Traveling Salesman Problem, Vertex Cover and Knapsack problems, Polynomial and Fully-Polynomial Approximation Schemes.
8. Graphs and Networks: Max flow and Matching.
9. Computational Geometry: Geometric sweeping, Maximal points, Convex-Hull, Nearest-Point, Voronoi Diagram, Delaunay Triangulation.

Course Policies

- ***Coursework includes*** participation, online/in-class discussions and activities, attendance, homework assignments, and quizzes. Active learning is implemented in this class. Students are expected to be positively engaged in the learning process.

- ***Course Website & Participation***: Students are required to periodically check the course website and download course material as needed.
  - Several resources will be posted through the website as well.
  - Blackboard will be used for communication and interaction, posting and submitting assignments, posting grades, posting sample exams, etc.
  - It is expected that you get benefit of the discussion board by raising questions or answering questions put by others.

- ***Attendance***: Regular attendance is a university requirement.
  - Attendance will be checked at each lecture.
  - Missing 20% of the classes will result in an automatic DN grade (without warning).
  - Late arrivals will disrupt the class session, and may be counted as a miss if repeated.
  - If you find yourself unable to attend a class, email the instructor ahead of time for better planning and management of the class. If you fail to do so, send your email as soon as you get a chance and provide your excuses if any.
  - Every unexcused absence may lead to a loss of 0.5% of total grade.

- ***Late assignments***: are subjected to late-penalty. See late submission policy on the course website/ Blackboard under the Assignments page.

- ***Re-grading policy***: If you have a complaint about any of your grades, discuss it with the instructor no later than 3 days of distributing the grades (except for the final). Only legitimate concerns on grading should be discussed.

- ***Office Hours***:
  - Students are encouraged to use the office hours to clarify and understand the material. Use the Blackboard (Bb) for quick points and homework questions.
  - For urgent issues, use emails instead of Bb-mails, please indicate ICS553 in the "Subject" field of your email (e.g. ICS553: Quiz1 score is missing).

- ***Academic honesty***:
    - Students are expected to abide by all the university regulations on academic honesty.
    - Cheating will be reported to the Department Chairman.
    - Although collaboration and sharing knowledge is highly encouraged, copying others' work without proper citation, either in part or full, is considered plagiarism. Whenever in doubt, review the university guidelines or consult the instructor.
- ***Courtesy***:
    - Students are expected to be courteous toward their classmates and the instructor throughout the duration of this course (in-class and online).
    - Side-talks and text-messages during the class are prohibited.