The University of Jordan

King Abdullah II School for Information Technology (KASIT)			
Computer Science Department			
Semester:	Spring	**Year:**	2022-2023

Course Information	
Course Title & Number	Computer Algorithms (CS 1901902) – Ph.D. Level
Prerequisite	------
Course Website	**http://elearning.ju.edu.jo**
Instructors	Prof. Azzam T. Sleit
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	Office Hours Monday & Wednesday 9:30-10:30 am
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Course Description
This is an advanced graduate-level course on algorithms, with an emphasis on computational problems that are central to both theory and practice, and on developing techniques for the design and rigorous analysis of algorithms for such problems. It discusses topics such as network flows, intractability, approximation algorithms (heuristics and metaheuristic algorithms), multithreaded algorithms, and parallel algorithms to deal with large data sets.

Course Objectives

- To provide a thorough treatment of the concepts and design principles of contemporary computer algorithms.

- To present the time and space complexity of algorithms.

- To measure the efficiency of algorithms.

- To design different algorithmic approaches, including divide-and-conquer, greedy, dynamic programming, backtracking, and approximation approaches (including heuristic and metaheuristic approaches).

- To present several NP-complete and NP-hard problems.

- To present network flows and their applications.

- To illustrate the design and implementation of multithreaded and parallel algorithms for various problems such as sorting, matrix multiplication, and graphs.

Intended Learning Outcomes (ILOs)

Upon successful completion of this course, students:

- Should be able to know and understand basic terms associated with computer algorithms, such as algorithms complexity and intractability, divide-and-conquer, greedy approach, dynamic programming, backtracking, approximation (heuristic and metaheuristic) algorithms, multithreading, parallel algorithms, etc.
- Should be able to select the appropriate algorithm to solve a given problem.
- Should be able to prove the correctness of an algorithm.
- Should be able to understand, design and implement different sequential and parallel algorithms for various problems such as network flows, sorting, computational and graph-based problems.

Teaching & Learning Methods

- Class lectures, lecture notes, assignments, and research projects are designed to achieve the course objectives.
- You should read the assigned chapters before class, participate in class and do whatever it takes for you to grasp these materials. Also, ask any questions related to computer algorithms.
- You are responsible for all material covered in the class.
- Please communicate with us regarding any concerns or issues related to computer algorithms either in class or by email.
- The course web page (**http://elearning.ju.edu.jo**) is a primary communication vehicle. Lecture notes, course syllabus, and project materials are available on the web page.

Assessment Policy

Assessment Type	Exam Dates	Weight
Midterm Exam	TBD	30%
Final Exam	TBD	40%
Research Project Report & Material	TBD	30%

Course Content

Weeks	Title	Topics in Computer Algorithms and Cases	Assignments
1-3	Computer Algorithms Overview	- Running Time and Space. - Properties of asymptotic notations - Sequential Approach. - Divide-and-Conquer. - Greedy Algorithms. - Dynamic Programming Algorithms. - Backtracking.	Reading in related topics

4-5	Multi-Dimensional Search Structures and Algorithms	• Point Data (k-d tree, Quadtrees) • Regional Data (R-Tree) • Space Transformation	
6-8	Intractability (NP-Problems)	• Decision and Optimization Problems • Polynomial Time vs. Non-Polynomial Time. • General Problem Categories. • The Sets P and NP. • Reducibility • Satisfiability • NP-Complete Problems. • NP-Hard Problems. • NP-Hard vs. NP-Complete Problems.	Reading in related topics
Week 7	**Mid Term Exam**		
9-10	Advanced Graph problems	• Network Flows • Flow Networks. • Maximum Flow. • Maximum Bipartite Matching. • Graph coloring	Reading in related topics
11	Approximation Algorithms	• Heuristic and Metaheuristic Algorithms	Reading in related topics
12	Linear Programing	• Definition • Problem formulation • The Simplex algorithm	Reading in related topics
13-14	Research	Presenting and discussing recent research problems in the field.	Reading in related topics
15	**Final Exam**		

References

- **Advanced Algorithms**, Michel X. Geomans, MIT/LCS/RSS-27, 1994.

- **Introduction to Algorithms**, by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, The MIT Press, Third Edition, 2009.

- **The Design and Analysis of Spatial Data Structures,** by Hanan Samet, 1990.

- **Analysis of Algorithms:** *An Active Learning Approach*, by Jeffrey J. McConnell, Second Edition, Jones & Bartlett, 2008.

- **Foundations of Algorithms**, by Richard Neopolitan, Fifth Edition, Jones & Bartlett, 2015.

- **Fundamentals of Computer Algorithms**, by Horowitz Ellis, Sahni Sartaj & Rajasekaran Sanguthevar, 2008.

- **Algorithm Design:** *Foundation, Analysis, and Internet Examples*, by Michael T. Goodrich and Roberto Tamassia, John Wiley & Sons, Inc., 2002.

- **Introduction to Parallel Computing**, by Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, Addison-Wesley an imprint of Pearson Education, Second Edition, 2003.

  (**http://www-users.cs.umn.edu/~karypis/parbook/**)

- **Introduction to Parallel Computing:** *Design and Analysis of Algorithms*, by Vipin Kumar, Ananth Grama, Anshul Gupta, and George Karypis, The Benjamin/Cummings Publishing Company, Inc. 1994.

- **Designing and Building Parallel Programs**, by Ian Foster, Addison-Wesley Publishing Company, 1995.

Course Regulations	
Exams	• The format for the exams is generally (but NOT always) as follows: General Definitions, Multiple-Choice, True/False, Analyze and solve a Problem, Short Essay Questions, etc.
Makeup Exams	• Makeup exams should not be given unless there is a valid excuse.
Cheating	• Honor Code: The honor code applies to all work turned in for this course including exams and assignments. Assignments are designed to facilitate students' learning of the concepts. It is important that you understand the solutions to all problems, and the best way to gain an understanding is to work them out and write them up by yourself. Hence the policy is that you must submit your own work and clearly list your references. You may not share your work with other students. Violating the policy will be taken as a no submission state for the assignment. University regulations will be preserved at all times. • Cheating or copying an exam or research project is an illegal and unethical activity. • Standard JU policy will be applied. • All graded assignments must be your work (in your own words).
Attendance	Participation means coming to class, asking relevant questions, taking part in useful discussions, not falling asleep, and so on. • Excellent attendance is expected. • The University of Jordan policy requires the faculty member to assign a ZERO grade (35) if a student misses 10% of the classes that are not excused. • If you miss class, it is your responsibility to find out about any announcements or assignments you may have missed.