The University of Jordan

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

Course Information	
Course Title & Number	Theory of Algorithms (CS 1901715)
Course Level	Graduate (Master Program)
Prerequisite	Data Structures (CS 1901231) & Theory of Algorithms (CS 1901341) – Undergraduate Level
Course Website	**http://elearning.ju.edu.jo**
Instructor	Prof. Azzam T. Sleit
Office Location	KASIT: First Floor – CS Department
Office Phone #	06-5355000
Office Hours	Monday & Wednesday 9:30 - 10:30 AM
e-mail	**azzam.sleit@ju.edu.jo**

Textbook	
Title	Introduction to Algorithms
Author(s)	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, & Clifford Stein
Publisher	The MIT Press
Edition & Year	Third Edition 2009
Book Website	**http://mitpress.mit.edu/algorithms/** **http://highered.mcgraw-hill.com/sites/0070131511/student_view0/**

References

- Richard E. Neapolitan, “Fundamentals of Algorithms”, Fifth Edition, Jones & Bartlett, 2015.
- Horowitz Ellis, Sahni Sartaj & Rajasekaran Sanguthevar, “*Fundamentals of Computer Algorithms*”, 2008.
- Jeffrey J. McConnell, "*Analysis of Algorithms: An Active Learning Approach*", Second Edition, Jones & Bartlett, 2008.
- Richard Johnsonbaugh and Marcus Schaefer, "*Algorithms*", Pearson/Prentice Hall, 2004.

Assessment Policy		
Assessment Type	**Expected Due Date**	**Weight**
Midterm Exam	TBA	30%
Final Exam	TBA	40%
Research Project Report	TBA	30%

Course Description

This course provides strategies for algorithms synthesis and analysis. Design methodologies of classical algorithm categories such as divide-and-conquer, greedy method, dynamic programming, search and traversal, backtracking, and branch-and-bound. Computational complexity and important theoretical results from lower-and upper-bound studies, NP-hard, and NP-complete problems will be addressed.

Course Main Goal

The main goal is to enable students to analyze different algorithms and techniques to predict how much time and space is required by a computer to run a program or solve a problem.

Course Objectives

The objectives of this course are to enable students to:

- Review and understand the concepts of designing, expressing, validating, analyzing, and testing algorithms.
- Understand the asymptotic notations and how to use them for best, average, and worst-case complexity.
- Express some algorithms recursively, and prove and solve recursive functions.
- Understand and analyze sequential, divide–and–conquer, greedy, dynamic, backtracking, branch-and-bound, and parallel algorithms.
- Distinguish between problems whose solution is by a polynomial time algorithm and problems for which no polynomial time (NP-Hard and NP-Complete problems).
- Compare between practical and theoretical results of algorithms' complexity.

Teaching/Learning & Assessment Methods

Teaching (T) Methods:

- Class contact is 3 hours per week. Several teaching methods will be deployed such as lectures, presentations, distributing handouts, answering questions, and discussion: lectures by a guest speaker.
- Lecture notes, exams (midterm and final), and projects are designed to achieve the course goals and objectives.

Learning (L) Methods:

- You should read the assigned topics before class, participate in class and do whatever it takes for you to grasp this material. Also, ask any question related to the Theory of Algorithms.
- You are responsible for all material covered in the class.
- Please communicate with me regarding any concerns or issues related to the Theory of Algorithms either in the class, course website, by phone, or by email.
- The website (elearning.ju.edu.jo) is a primary communication vehicle. Lecture notes, presentations, and course syllabus are available on the web.

Assessment (A) Methods:

- There will be several assessment methods for evaluating the performance of the students, such as in-class questions, research projects, and conducting midterm and final exams.

Intended Learning Outcomes (ILOs)

Upon successful completion of this course, students can:

A- Knowledge and Understanding:

A1) Know and understand terms associated with algorithms, such as time and space complexities, Big O notation, Big Omega notation, Big Theta notation, etc.
A2) Know and understand terms associated with graphs, such as directed and undirected graphs, path, simple path, cycle, strongly and weakly connected graphs, tree, forest, etc.
A3) Know and understand various algorithm design methods, such as sequential, divide-and-conquer, greedy, dynamic programming, backtracking, and branch-and-bound, using various applications. such as sorting, searching, knapsack problem, minimum spanning tree, multistage graphs, traveling salesperson problems, n-queens, and Hamiltonian cycles.
A4) Know and understand various NP-Hard and NP-Complete problems.
A5) Know and understand various parallel algorithms.

B- Cognitive and Intellectual Skills:

B1) Compare, analyze, and evaluate various algorithms, such as sorting, searching, knapsack problem, minimum spanning tree, multistage graphs, traveling-salesperson problem, n-queens problem, and Hamiltonian cycles.
B2) Compare, analyze, and evaluate various NP-Hard and NP-Complete problems.
B3) Compare, analyze, and evaluate various parallel algorithms.

C- Subject-Specific Skills:

C1) Design various algorithms, such as sorting, searching, knapsack problem, etc., using various methods, such as sequential, divide-and-conquer, greedy, backtracking, etc.
C2) Solve a recurrence function and express it as asymptotic notation.
C3) Correctly analyze the complexity of given algorithms using various methods, such as sequential, divide-and-conquer, greedy, dynamic, backtracking, etc.
C4) Implement various algorithms and compare their running time and their theoretical complexities.

Course Contents, Teaching/Learning & Assessments Methods with ILOs

Module & Number of Weeks	Topic Details	Teaching/Learning & Assessments Methods	ILOs
Modules 1 & 2 (2 Week)	Overview Properties of Asymptotic notations	**T:** Lecture & Discussion **L:** Reading Modules 1 & 2 **A:** In-class questions	A1, A3, B1, C1, C3
Modules 3 & 4 (2 Week)	Sequential Method Divide-and-Conquer Method	**T:** Lecture & Presentation **L:** Reading Modules 3 & 4 **A:** In-class questions	A3, B1, C1, C3
Module 5 (1 Week)	Methods for Solving Recurrences: Iteration Method and Master Theorem.	**T:** Lecture & Presentation **L:** Reading Module 5 **A:** In-class questions	C2
Module 6 (1 Week)	Graphs Applications on Graphs; Graph Terminologies; and Graph Representation.	**T:** Lecture & Presentation **L:** Reading Module 6 **A:** In-class questions	A2
Module 7 (1 Week)	Graph-Based Search Algorithms	**T:** Lecture & Presentation **L:** Reading Module 7 **A:** In-class questions	A3, B1, C1, C3
Midterm Exam (1 Lecture)	Midterm Exam Covers Modules: 1 – 7	**A:** Midterm Exam	--
Module 8, 9 (1 Week)	Greedy Method General Method; Minimum Spanning Tree; and Knapsack Problem. Dynamic Programming Method General Method; Traveling Salesperson Problem.	**T:** Lecture & Presentation **L:** Reading Module 8 **A:** In-class questions	A3, B1, C1, C3
Module 10, 11 (1 Weeks)	Backtracking Method General Method; Generic Problem Formulation; Backtracking Examples; n-Queens Problem Branch-and-Bound Method General Method; Branch-and-Bound	**T:** Lecture & Presentation **L:** Reading Module 9 **A:** In-class questions	A3, B1, C1, C3
Module 12	Advanced search structures and	**T:** Lecture & Presentation	A3, B1, C1,

(2 Weeks)	algorithms B-Trees; B+ - Tress	**L:** Reading Module 10 **A:** In-class questions	C3
Module 13 (1 Week)	NP-Hard and NP-Complete	**T:** Lecture & Presentation **L:** Reading Module 11 **A:** In-class questions	A3, B1, C1, C3
(3 Weeks)	Research Presenting and discussing recent research problems in the field.	**T:** Lecture & Presentation **L:** Reading Module 11 **A:** In-class questions	A3, B1, C1, C3
Project (1 Week)	Research Project Presentations	**A:** Project Presentations	A3, A5, B1, B3, C1, C4
Final Exam	Final Exam Covers All Modules	**A:** Final Exam	--

Course Regulations & Ethics	
Project Assignments	• A research project will be assigned for each group (check project guidelines).
Exams	• The format for the exams is generally (but NOT always) as follows: General Definitions, Multiple-Choice, True/False, Analyze a Problem, Short Essay Questions, Solving Problems, 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	• Excellent attendance is expected. • The University of Jordan policy requires the faculty member to assign a ZERO grade (F) 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.
Workload	• The average workload student should expect to spend 8 hours per week.

Participation	Participation means coming to class, asking relevant questions, taking part in useful discussions, not falling asleep, and so on. • Attendance, participation in and contribution are required. • Making any kind of disruption during class-time will not be tolerated.
Concerns or Complaints	• Concerns or complaints should be expressed in the first instance to the module lecturer; if no resolution is forthcoming, then the issue should be brought to the attention of the module coordinator (for multiple sections) who will take the concerns to the module representative meeting. Thereafter, problems are dealt with by the Department Chair and if still unresolved the Dean and then ultimately the Vice President. For final complaints, there will be a committee to review the grading of the final exam.
University Regulations	• For more details on University regulations please visit: http://www.ju.edu.jo/rules/index.htm