SULTAN QABOOS UNIVERSITY

COLLEGE OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

BACHELOR OF SCIENCE IN COMPUTER SCIENCE

COURSE OUTLINE

I. COURSE INFORMATION			
COURSE CODE	COMP4204		
COURSE TITLE	Advanced Data Structures and Algorithms		
OMAN QUALIFICATION FRAMEWORK (OQF) LEVEL	8		
CREDIT HOURS	3		
CONTACT HOURS	4		
PRE-REQUISITES	COMP3203		
CO-REQUISITES			
EQUIVALENT COURSES			
INCOMPATIBLE COURSES			
COURSE CATEGORY	☐ University Requirement	☐ University Elective	
	☐College Requirement	☐ College Elective	
	☐ Department Requirement	☐ Department Elective	
	☒ Major Requirement	☐ Major Elective	
	☐ Specialization Requirement	☐ Specialization Elective	
	☐ Other (specify):		
COURSE OWNER	College: Science	Department: Computer Science	
	Center:	Unit:	
DELIVERY MODE	☒ Face to Face	☐ Blended	☐ Online
COURSE TYPE	☐ Lecture	☐ Lecture/Lab	
	☐ Lecture/Seminar	☐ Lecture/Studio	
	☒ Lecture/Tutorial	☐ Lecture/Lab/Tutorial or Seminar	
	☐Tutorial	☐ Laboratory (Practical)	
	☐ Field or Work Placement	☐ Studio	
	☐Seminar	☐ Internship	
	☐ Workshop	☐ Project	
	☐ Thesis	☐ Other (specify):	
LANGUAGE OF INSTRUCTION	English		
COURSE DESCRIPTION	This course provides a study of advanced data structures and algorithms for solving a number of fundamental computing problems. It includes coverage of advanced methods and techniques for designing algorithms using appropriate data structures and analyzing their efficiency.		

TEACHING AND LEARNING STRATEGIES	☐ Augmented Reality	☐ Flipped Classroom	
	☐ Blended Learning	☒ Problem-Based Learning	
	☐ Discovery-Based Learning	☐ Project-Based Learning	
	☐ Student-Led Learning	☒ Team-Based Learning	
	☐ Work-Based Learning	☐ Other (specify):	
ASSESSMENT COMPONENT AND WEIGHT	☒In-term examination(s) (30%)	☒ Quizzes (10%)	☐Other (specify): (%)
	☒ Homework assignments (20%)	☐Project (%)	
	☒ Final examination (40%)	☐ Practical/ Lab (%)	
TEXTBOOKS AND EDUCATIONAL MATERIAL	Data Structures and Algorithm Analysis, online edition 3.2(Java Version), Clifford A. Shaffer, Department of Computer Science, Virginia Tech, (http://people.cs.vt.edu/~shaffer/Book/) **Reference:** Algorithms in C++ (Parts 1-4), by Sedgewick, 3rd Ed, Addison Wesley, 1998		
GRADING METHOD	☒ A-F Scale	☐ Pass/Not Pass	☐ Other (specify):

GRADING METHOD DESCRIPTION

	Range	Letter Grade	Description
A-F GRADING SCALE:	90 – 100	A	**Exceptional performance:** All course objectives achieved and met in a consistently outstanding manner.
	86 – 89.9	A-	
	81– 85.9	B+	**Very Good Performance:** The majority of the course objectives achieved (majority being at least two-thirds) and met in a consistently thorough manner.
	77 – 80.9	B	
	73 – 76.9	B-	
	68 – 72.9	C+	**Satisfactory Performance:** At least most of course objectives have been achieved and met satisfactorily.
	64 – 67.9	C	
	60 – 63.9	C-	
	55 – 59.9	D+	**Minimally Acceptable Performance:** The course objectives met at a minimally acceptable level.
	50 – 54.9	D	
	0 – 49.9	F	**Unacceptable performance:** The course objectives not met at a minimally acceptable level.

II. Semester Information			
Semester/Year	Spring 2025	**Section(s)**	1
Day and Time	Section (1): SUN & TUE 12:00-13:50	**Venue(s)**	Section (1): D12
Course Coordinator	Dr. Farha Al Kharusi	**Course Team**	
Coordinator Office	0209	**Office Hours**	MON & TUE 10:30-11:30
Coordinator Extension	2228	**Coordinator Email**	farha@squ.edu.om

III. Alignment of Course Learning Outcomes (CLO), Program Learning Outcomes (PLO), Graduate Attributes (GA), and Oman Qualification Framework (OQF) Characteristics

CLO	PLO / SO	SQU Graduate Attributes	OQF Characteristics
1. Describe techniques for analyzing the efficiency of an algorithm.	SO2	A	1
2. Describe clearly and implement correctly some advanced searching algorithms.	SO2	B	1
3. Describe clearly and implement correctly some indexing techniques.	SO2	B	1
4. Analyze tradeoffs for selecting appropriate data structures and algorithms for a specific problem.	SO1, SO2	B	1
5. Describe clearly and implement correctly some advanced structures such as graphs, non-binary trees, … etc.	SO1, SO2	B	1
6. Implement correctly Depth-First and Breadth-First algorithms on graphs.	SO2	B	1
7. Evaluate the performance of algorithms using Big Oh notations and experimental.	SO2	B	1
8. Describe the different patterns of algorithms commonly used for solving real-life problems.	SO2, SO6	B	1
9. Explore and use data-structures not covered in the course.	SO1, SO2	E	1

IV. COURSE LEARNING OUTCOMES (CLOS) AND ASSESSMENT CRITERIA AND METHODS (FOR EACH CLO)		
CLO1: Describe techniques for analyzing the efficiency of an algorithm.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Measure the efficiency of an algorithm using Big-O, Ω, Θ	Hw1, 2, 3, 4, Quiz 1, 2, MT, Final
B)	Find the relationship between two algorithmic functions by using the limit.	Hw1, Quiz 1, MT, Final
C)	Find the growth rate of an algorithm and its basic ADT operation	Hw1, Quiz 1, MT, Final
D)	Describe the best, average and worst cases performance of an algorithm	Hw1, Quiz 1, MT, Final
CLO2: Describe clearly and implement correctly some advanced searching algorithms.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Describe different general tree representations and K-ary trees	Hw2, Quiz 1, MT, Final
B)	Describe graph representations	Hw4, Quiz 2, Final
CLO3: Describe clearly and implement correctly some indexing techniques.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Describe different types of linear indexing	Hw3, Quiz 2, Final
B)	Describe 2-3 tree, B-tree, B+ tree indexing representations, and inserting and deleting new records.	Hw3, Quiz 2, Final
C)	Describing the basic operations inserting and deleting records.	Hw3, Quiz 2, Final
CLO4: Analyze tradeoffs for selecting appropriate data structures and algorithms for a specific problem.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Analyze the tradeoffs of the different representations of general tree	Hw2, Quiz 1, MT, Final
B)	Analyze the tradeoffs of the different linear indexing representations	Hw3, Quiz 2, Final
C)	Analyze the tradeoffs of the different graph's representations and algorithms	Hw4, Quiz 2, Final
D)	Analyze the tradeoffs of the different sorting algorithms	Hw2, Quiz 1, Final
E)	Analyze the tradeoffs of the different searching algorithms	Hw3, Quiz 2, Final

CLO5: Describe clearly and implement correctly some advanced structures such as graphs, non-binary trees, … etc.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Describe and implement some operation of non-binary tree	Hw2, Quiz1, MT, Final
B)	Describe the implementation of graph representations	Hw4, Quiz2, Final
CLO6: Implement correctly Depth-First and Breadth-First algorithms on graphs.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Implement the depth-first and the breadth algorithms on graphs	Hw4, Quiz2, Final
B)	Understand the use of stack and queue on these algorithms	Hw4, Quiz2, Final
C)	Discuss the running time and the space used in these algorithms	Hw4, Quiz2, Final
CLO7: Evaluate the performance of algorithms using Big Oh notations and experimental.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Implement an algorithm of a problem and discuss find the empirical results on some inputs.	Hw1, Quiz1, MT, Final
B)	Discuss and justify the empirical results and compared it with asymptotic analysis.	Hw1, Quiz1, MT, Final
CLO8: Evaluate the performance of algorithms using Big Oh notations and experimental.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Describe dynamic programming of algorithms commonly used such as Knapsack Problem and All-Pairs Shortest Paths Problem	Hw4, Final
B)	Describe randomized algorithms for solving real-life problems	Hw4, Final
CLO9: Explore and use data-structures not covered in the course.		
ASSESSMENT CRITERIA (TO ACHIEVE THIS OBJECTIVE, THE STUDENT MUST)		**ASSESSMENT METHODS**
A)	Describe data-structure not covered in the course	Hw4, Final
B)	Describe basic operations of a data-structure not covered in the course	Hw4, Final
C)	Describe the resources used in the data-structure not covered in the course.	Hw4, Final

V. COURSE CONTENT AND SCHEDULE				
WEEK	**LECTURES #**	**TOPICS/ SUBJECTS**	**READINGS/ CHAPTERS**	**REMARKS (e.g., ASSESSMENTS)**
1		Introduction: The need of Data Structures, Costs and Efficiency, ADT and Data Structures, Problems and Algorithms General Introduction & Mathematical Preliminaries: Set concepts and Notations, Logarithms, Summations, Recursion, Basic Recurrence Relations, Mathematical Proof Techniques	Chapter 1, 2	HW1, MT, Quiz1,and/or Final
2		Algorithm Analysis: Best, Worst, and Average Cases; Asymptotic Vs. Empirical Analysis	Chapter 3	HW1, MT, Quiz1, and/or Final
3		Non-Binary Trees: General Tree Implementation, K-ary Trees	Chapter 6	HW2, MT, Quiz1, and/or Final
4		Non-Binary Trees: General Tree Implementation, K-ary Trees	Chapter 6	HW2, MT, Quiz1, and/or Final
5		Sorting: Bin-sort and Radix sort Implementations Comparison of Sorting Algorithms	Chapter 7	HW2, MT, Quiz1, and/or Final
6		Searching: Use of Self-organizing Lists and Bit-Vectors	Chapter 9	HW3, MT, Quiz2, and/or Final
7		Indexing: Linear Indexing	Chapter 10	HW3, Quiz2, and/or Final
8		Indexing: Tree-based Indexing	Chapter 10	HW3, Quiz2, and/or Final
9		Graphs: Graph Implementations, Graph traversals.	Chapter 11	HW4, Quiz2, and/or Final
10		Graphs: Shortest- Path Problem	Chapter 11	HW4, Quiz2, and/or Final
11		Graphs: Minimum Spanning Tree	Chapter 11	HW4, and/or Final
12		Patterns of Algorithms: Dynamic Programming, Randomized Algorithms	Chapter 16	HW4, and/or Final
13		Patterns of Algorithms: Dynamic Programming, Randomized Algorithms	Chapter 16	HW4, and/or Final
14		Advanced Tree Structures: Tries and Balanced Trees.	Chapter 13	HW4, and/or Final Final
15		**General Revision**		

VI. ADDITIONAL INFORMATION (e.g., RUBRICS, etc.)

Assessment Plan:

Item	Date out/In	Sections of Weeks	Marks
Assignment 1	Week 3/5	1 – 2	5%
Assignment 2	Week 5/8	3 – 5	5%
Quiz 1	Week 6 11 March 2025 (Tuesday)	1 – 5	5%
Midterm exam	Week 8 23 March 2025 (Sunday)	1 – 8	30%
Assignment 3	Week 8/11	6 – 8	5%
Quiz 2	Week 12 22 April 2025 (Tuesday)	9 – 11	5%
Assignment 4	Week 11/14	9 - 14	5%
Final	**24th May 2025 (SAT 15:00-18:00)**	All	40%

Department's Late Submission Policy:

(a) 1-24 hours: 25% of the mark will be deducted.
(b) > 24 hours: Not accepted.

Department's Policy for Dealing with Cheating:

It is essential that each student solves all programming assignments, lab tests and exams individually unless instructed otherwise, e.g., for group projects. Copying, plagiarism, collusion, switching, and falsification are violations of the university academic regulations. Students involved in such acts will be severely penalized. The department has adopted a firm policy on this issue. A zero mark will be assigned the first time a student is caught involved in copying and his/her name will be added to a watch list maintained by the Head of Department. Further repeated involvements in copying will cause the student to get an F grade in that course. This is in line with the university academic regulations.

VII. STUDENTS RESPONSIBILITIES

It is the student's responsibility to know and comply with all University Academic Regulations relevant to participation in this course. These regulations specifically include attendance requirements and student academic code of conduct.

ACADEMIC INTEGRITY	The University expects the students to approach their academic endeavors with the highest academic integrity. Please refer to the **Undergraduate Academic Regulations**.
ADD AND DROP	Students who wish to drop or add the course should review the **Undergraduate Academic Regulations**.
ATTENDANCE	Sultan Qaboos University has a clear requirement for students to attend courses, detailed in the **Undergraduate Academic Regulations**.

ASSESSMENT AND GRADING	To ensure the provision of a sound and fair assessment and grading, please review the **Undergraduate Academic Regulations**.
GRADE APPEAL	Students who wish to appeal their grades should review the **Undergraduate Academic Regulations**.
CLASSROOM POLICIES	Students are expected to dress professionally during class time as required by the University. Use of phones or any other electronic devices in the classroom during class time is strictly prohibited. Unauthorized use may lead to faculty member confiscation of the device for the remainder of the class. Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. A student responsible for disruptive behavior may be required to leave the class.
LATE AND MAKE-UP WORK	Students are required to meet the course objectives by submitting coursework no later than the assigned due date. Students may be allowed to submit late work if approved by the course coordinator. Assignments submitted after the due date may be penalized.
MISSED EVALUATIONS	All quizzes, tests, clinical evaluations, and exams must be completed by the date they are assigned. If a quiz, test, or exam is missed due to a documented emergency situation (e.g., medical emergency, death in the immediate family), it is the student's responsibility to contact the instructor.
OTHER	

Course Outline Appendix

1. **PROGRAM LEARNING OUTCOMES / STUDENT OUTCOMES**
    1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
    2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
    3. Communicate effectively in a variety of professional contexts.
    4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
    5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
    6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

2. **SQU Graduate Attributes SQU Graduate Attributes and Competencies for Undergraduate Studies**

GRADUATE ATTRIBUTES	GRADUATE COMPETENCIES FOR UNDERGRADUATE STUDIES
A. Cognitive Capabilities: The graduate has sufficient general and specialized theoretical knowledge that enables him/her to deal well with his/her specialty and other related fields.	1. Demonstrates familiarity and works with advanced specialized knowledge in the area of specialization.
	2. Demonstrates a general understanding of the relationship of advanced specialized knowledge with knowledge in other relevant professional fields and aspects.
	3. Demonstrates a comprehensive understanding of the theories, principles, and methods used in his/her specialty, and how to create and apply new knowledge.
	4. Demonstrates general knowledge of the legal environment and necessary relevant regulatory frameworks.
	5. Shows awareness of contemporary literature and research.
B. Skill and Professional Capability: The graduate has sufficient skill and practical experience that enables him/her to perform all tasks related to the specialization and other related fields.	1. Applies concepts, theories, and investigative methods to synthesize and interpret information to evaluate conclusions.
	2. Applies appropriate research methods and techniques and employs digital knowledge
	3. Evaluates and critiques information independently
	4. Uses cognitive and technical skills to analyze complex issues and develop appropriate solutions.

	5. Initiates new ideas or processes in the professional, educational or research context.
C. Effective Communication: The graduate has the ability to communicate effectively with others to achieve the desired results	1. Explains, presents, and adapts information to suit the recipients.
	2. Employs appropriate information and communication technology to collect and analyze information.
D. Autonomy and Leadership: The graduate has the ability to lead, make decisions and take responsibility for decisions.	1. Performs advanced professional activities independently.
	2. Demonstrates leadership skills.
	3. Takes professional responsibility.
	4. Assumes full accountability for the tasks and their output.
E. Responsibility and Commitment: The graduate appreciates the importance of available resources and deals with them effectively and is committed to the ethics of the profession and society.	1. Manages time and other resources assigned to accomplishing tasks effectively and responsibly.
	2. Demonstrates effective practices when working in teams.
	3. Demonstrates advanced levels of understanding of values and ethics relevant to the specialization, profession and local and international society and promotes them among others.
	4. Works within the professional, institutional, and specialization guiding frameworks and strategic plans.
	5. Interacts with community affairs positively and preserves national identity.
F. Development and Innovation: The graduate has a passion for development and innovation in the field of specialization.	1. Demonstrates the ability to independently manage learning tasks, with an awareness of how to develop and apply new knowledge.
	2. Utilizes specialized knowledge and skills for entrepreneurship.
	3. Utilizes creative and innovative skills in the field of specialization.

3. **OQF Characteristics**
   1. Knowledge
   2. Skills
   3. Communication, Numeracy, and Information and Communication Technology Skills.
   4. Autonomy and Responsibility
   5. Employability and Values
   6. Learning to learn