COURSE OUTLINE

	**SULTAN QABOOS UNIVERSITY** **COLLEGE OF SCIENCE** **BACHELOR OF SCIENCE IN COMPUTER SCIENCE** **DISTRIBUTED SYSTEMS**

I. COURSE INFORMATION		
COURSE CODE	COMP5504	
COURSE TITLE	DISTRIBUTED SYSTEMS	
OMAN QUALIFICATION FRAMEWORK (OQF) LEVEL	**8**	
CREDIT HOURS	3	
CONTACT HOURS	3	
PRE-REQUISITES	COMP4506	
CO-REQUISITES	NONE	
EQUIVALENT COURSES	NONE	
INCOMPATIBLE COURSES	NONE	
COURSE CATEGORY	Specialization Requirement	
COURSE OWNER	College: Science	Department: Computer Science
DELIVERY MODE	Face to Face	
COURSE TYPE	Lecture/Tutorial	
LANGUAGE OF INSTRUCTION	English	
COURSE DESCRIPTION	This course introduces students to key principles and techniques underlying the development of distributed computing systems. Topics include inter-process communication, remote invocation, distributed naming, distributed file systems, security, distributed clocks, process coordination, concurrency control, replication and fault-tolerance. Examples of systems discussed include cloud computing, grid computing, storage systems, peer-to-peer networks and Web services.	

TEACHING AND LEARNING STRATEGIES	Problem-Based Learning
	Project-Based Learning
	Team-Based Learning
	Work-Based Learning
ASSESSMENT COMPONENT AND WEIGHT	In-term examination(s) (25%)
	Homework assignments (15%)
	Project (20%)
	Final examination (40%)
TEXTBOOKS AND EDUCATIONAL MATERIAL	- Book 1: Distributed Systems, Maarten Van Steen and Andrew Tanenbaum, 4th edition, Version 4.03 (January 2025). - Book 2: Distributed Systems, Concepts and Design, G. Coulouris, J. Dollimore, T. Kindberg and G. Blair, Pearson (5th edition., 2012).
Textbooks Web Sites: Book1: https://www.distributed-systems.net/index.php/books/ds4/; Book 2: www.cdk5.net	
Socket Interfaces: https://docs.oracle.com/cd/E19683-01/806-4125/6jd7pe6bt/index.html	
Sun RPC Tutorial: https://docs.oracle.com/cd/E19683-01/816-1435/rpcgenpguide-21470/index.html	
Java RMI Tutorial: https://docs.oracle.com/javase/tutorial/rmi/index.html	
MPI Tutorial: https://computing.llnl.gov/tutorials/mpi/	
Pthreads Tutorial: https://computing.llnl.gov/tutorials/pthreads/	
OpenMP Tutorial: https://computing.llnl.gov/tutorials/openMP	
CUDA Tutorial: https://www.tutorialspoint.com/cuda/index.htm	
CUDA Documentation: https://docs.nvidia.com/cuda/	
Hadoop Tutorial: https://www.tutorialspoint.com/hadoop/index.htm	
Spark Tutorial: https://www.tutorialspoint.com/apache_spark/index.htm	
Cloud Computing Tutorial: https://www.tutorialspoint.com/cloud_computing/index.htm	
GRADING METHOD	**X** 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 the course objectives 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)**	10
Day and Time	Sunday, Tuesday 14:15 – 16:05	**Venue(s)**	E11
Course Coordinator	Khaled Day	**Course Team**	
Coordinator Office	0007	**Office Hours**	Monday, Wednesday 11:00 – 12:00
Coordinator Extension	2231	**Coordinator Email**	kday@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	SQU Graduate Attributes	OQF Characteristics
1. Identify basic characteristics and architectural models of distributed computing systems.	SO1	A	**1**
2. Identify the problems and challenges behind developing distributed computing applications.	SO1	**A**	**1**
3. Analyze and evaluate basic algorithms and models for distributed computing systems, including issues related to inter-process communication, time synchronization, coordination, and concurrency control.	SO2, SO6	**B**	**2**
4. Design and implement a distributed computing application, using mechanisms such as client/server socket communication, remote procedure calls, RMI, etc.	SO2, SO6	**B**	**2**
5. Discuss the tradeoffs for improving the performance and reliability of distributed computing applications.	SO2	**B**	**2**
6. Investigate the trends and problems of current distributed systems.	SO1	**B**	**2**

IV. Course Learning Outcomes (CLOs) and Assessment Criteria and Methods		
CLO1: Identify basic characteristics and models of distributed computing systems.		
Assessment Criteria		**Assessment Methods**
A)	Identify basic characteristics of distributed systems.	Homework, Midterm Exam, Final Exam
B)	Identify basic models of distributed systems.	Homework, Midterm Exam, Final Exam
CLO2: Identify the problems and challenges behind developing distributed computing applications.		
Assessment Criteria		**Assessment Methods**
A)	Identify the issues to address when developing distributed computing applications.	Homework, Midterm Exam, Final Exam
B)	Identify the challenges faced when addressing these issues.	Homework, Midterm Exam, Final Exam
CLO3: Analyze and evaluate basic algorithms and models for distributed computing systems, including issues related to inter-process communication, time synchronization, coordination, and concurrency control.		
Assessment Criteria		**Assessment Methods**
A)	Analyze and evaluate basic algorithms and models for distributed inter-process communication.	Homework, Midterm, Final
B)	Analyze and evaluate basic algorithms and models for distributed time synchronization.	Homework, Midterm, Final
C)	Analyze and evaluate basic algorithms and models for distributed process coordination.	Homework, Midterm, Final
D)	Analyze and evaluate basic algorithms and models for concurrency control.	Homework, Midterm, Final
CLO4: Design and implement a distributed computing application, using mechanisms such as client/server socket communication, remote procedure calls, or RMI.		
Assessment Criteria		**Assessment Methods**
A)	Design a distributed computing application using mechanisms such as client/server socket communication, remote procedure calls, or RMI.	Homework, Project, Midterm, Final
B)	Implement a distributed computing application using mechanisms such as client/server socket communication, remote procedure calls, or RMI.	Homework, Project, Midterm, Final
CLO5: Discuss the tradeoffs for improving the performance and reliability of distributed computing applications.		
Assessment Criteria		**Assessment Methods**
A)	Discuss the tradeoffs for improving the performance of distributed computing applications.	Homework, Midterm, Final
B)	Discuss the tradeoffs for improving the reliability of distributed computing applications	Homework, Midterm, Final
CLO6: Investigate the trends and problems of current distributed systems.		
Assessment Criteria		**Assessment Methods**
A)	Investigate the trends of current distributed systems.	Homework, Midterm, Final
B)	Investigate the problems of current distributed systems.	Homework, Midterm, Final

V. COURSE CONTENT AND SCHEDULE				
WEEK	**LECTURES #**	**TOPICS/ SUBJECTS**	**READINGS/ CHAPTERS**	**REMARKS (e.g., ASSESSMENTS)**
1	1 and 2	Characteristics and Architectures of Distributed Systems	Chap 1-2 (Book 1) Chap 1-2 (Book 2)	HWK 1, Midterm, Final
2	1 and 2	Characteristics and Architectures of Distributed Systems	Chap 1-2 (Book 1) Chap 1-2 (Book 2)	HWK 1, Midterm, Final
3	1 and 2	Processes, Threads, Clients and Servers	Chap 3 (Book 1) Sec 7.4 (Book 2)	HWK 1, Midterm, Final
4	1 and 2	Inter-process Communication	Chap 4 (Book 1) Chap 4 (Book 2)	HWK 1, Midterm, Final
5	1 and 2	Inter-process Communication	Chap 4 (Book 1) Chap 4 (Book 2)	HWK 1, Midterm, Final
6	1 and 2	Remote Invocation	Chap 4 (Book 1) Chap 5 (Book 2)	HWK 2, Midterm, Final
7	1 and 2	Remote Invocation	Chap 4 (Book 1) Chap 5 (Book 2)	HWK 2, Midterm, Final
8	1 and 2	Review for Midterm Exam Midterm Exam	-	-
9	1 and 2	Clock Synchronization and Logical Clocks	Sec 5.1-2 (Book 1) Chap 14.1-4 (Book 2)	HWK 2, Final
10	1 and 2	Coordination and Agreement	Sec 5.3-4 (Book 1) Chap 15.1-3 (Book 2)	HWK 2, Final
11	1 and 2	Coordination and Agreement	Sec 5.3-4 (Book 1) Chap 15.1-3 (Book 2)	HWK 2, Final
12	1 and 2	Distributed Naming	Chap 6 (Book 1) Chap 13 (Book 2)	HWK 2, Final
13	1 and 2	Consistency and Replication	Chap 7 (Book 1) Chap 17-19 (Book 2)	HWK 2, Final
14	1 and 2	Fault Tolerance	Chap 8 (Book 1) Sec 18.3 (Book 2)	HWK 2, Final
15	1 and 2	Project Presentations		Project

VI. Additional Information (e.g., Rubrics, etc.)

Project (groups of 4 students each):

Task 1 – Proposal (by week 4): Read about different communication methods and tools used in distributed systems such as Sockets, RPC, RMI, MPI, OpenMP, etc. (see provided links on page 2). Propose a distributed application and select a communication method/tool (Sockets, RPC, RMI, MPI, etc.) to use for implementing your proposed application. Examples of applications: distributed file sharing, distributed chatting, distributed task queue, etc. You may also opt to develop a parallel computing solution for a high-performance computing problem. Submit a proposal indicating the proposed application and the selected communication method/tool and get instructor approval.

Task 2 – Progress Report (by week 9): Design a solution for the selected application. Submit a progress report that includes the following sections: (1) Abstract; (2) Background Information (providing background information about the selected application and the communication method/tool); (3) Design (use pseudo-code, charts, and figures in addition to text to describe your solution design); References.

Task 3 – Implementation (by week 13): Implement and test your designed solution**.**

Task 4 – Final Report (by week 14): Submit a project final report extending the project progress report by adding the following sections: (4) Implementation; (6) Conclusion; (7) References; and (8) Appendix containing a copy of all your source code plus screenshots of complete testing runs.

Task 5 – Presentation (in week 15): Give a 20-minute PowerPoint presentation describing your project work.

Assessment Plan

	Date Out	Due Date	Weight
HW1	W4	W7	7.5%
Midterm Exam		W8	25%
Project Progress Report		W9	5%
HW2	W9	W12	7.5%
Project Final Report		W14	10%
Project Presentation		W15	5%
Final Exam	Sunday 25 May 2025 – 8:00-11:00		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.

Course Outline Appendix

1. PROGRAM LEARNING OUTCOMES

SO1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.

SO2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.

SO3. Communicate effectively in a variety of professional contexts.

SO4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.

SO5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.

SO6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

2. 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	1. Manages time and other resources assigned to accomplishing tasks effectively and responsibly.
	2. Demonstrates effective practices when working in teams.

effectively and is committed to the ethics of the profession and society.	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