# COURSE OUTLINE

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| **Department:** | Faculty of Computing | **Knowledge Group:** | Communication Networks & Cloud Computing | |
| **Programme:** | Computer Science | **Class:** | BSCS-12 ABC 6th semester | |
| **Course code:** | CS-432 | **Academic Session/Semester:** | | Spring 2025 |
| **Course name:** | Parallel & Distributed Computing | **Pre/co requisite (course name and code, if applicable):** | | CS-330 or Equivalent |
| **Credit hours:** | 3+1 | | | |

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| **Course Synopsis** | This course introduces and familiarizes students with the design and implementation of distributed systems. The course will cover both theoretical and practical aspects of distributed systems. | | | |
| **Course Learning Outcomes (CLOs)** | At the end of the course the students will be able to:<br>1. **Describe** the theoretical and conceptual foundations of distributed computing<br>2. **Differentiate** architectural paradigms of an existing parallel & distributed systems<br>3. **Assess** distributed applications utilizing required evaluation measures.<br>4. **Develop** distributed applications using platforms (Solr or Omnet++) | | | |
| **Course Schedule** | Sec-A: **WED** CR-14 (10-12PM) & **THR** (10-11AM)<br>Sec-B: **THR** CR-14 (9-10AM) & **FRI** (9-11AM)<br>Sec-C: **MON** CR-15 (2-3PM) & **WED** (3-5PM) | | | **Labs** Sec-A **Friday** (9-1PM)<br>Sec-B **Friday** (2-5PM)<br>Sec-C **Thursday** (2-5PM) |
| **Course lecturer** | **Name** | **Office** | **Contact** | **E-mail** |
| | Dr. Khurum Shahzad (AB)<br>Dr. Shah Khalid (C) | A-308<br>A-205 | 2557 | mkshahzad@seecs.edu.pk<br>shah.khalid@seecs.edu.pk |
| Lab Engineer | Mr. Aftab Farooq | | | aftab.farooq@seecs.edu.pk |

**Mapping of the Course Learning Outcomes (CLO) to the Programme Learning Outcomes (PLO), Teaching & Learning (T&L) methods and Assessment methods: (Tentative CLOs/PLOs mapping)**

| No. | Course Learning Outcomes | PLO (SE) | PLO (CS) | BT Level | Teaching & Learning Methods | Assessment Methods |
|---|---|---|---|---|---|---|
| CLO 1 | **Describe** the theoretical and conceptual foundations of distributed computing | PLO-1 | NA | C-2 (Understand) | Active learning, Cooperative Learning, Blended Learning | Assignment<br>Quiz<br>MSE<br>ESE |
| CLO 2 | **Differentiate** architectural paradigms of an existing parallel & distributed systems | PLO-2 | NA | C-4 (Analyze) | Active learning, Cooperative Learning, Blended Learning | Assignment<br>Quiz<br>MSE<br>ESE |
| CLO 3 | **Assess** distributed applications utilizing required evaluation measures. | PLO-4 | NA | C-5 (Evaluate) | Active learning, Cooperative Learning, Blended Learning | Assignment<br>Quiz<br>MSE<br>ESE |
| CLO 4 | **Develop** distributed applications using platforms (Solr or Omnet++) | PLO-4 | NA | C-6 (Create) | Active learning, Cooperative Learning, Blended Learning | Assignment<br>Quiz<br>MSE<br>ESE |

**Details on Innovative T&L practices:**

| No. | Type | Implementation |
|---|---|---|
| 1. | Active learning | Conducted through in-class or hands-on activity. |
| 2. | Cooperative learning | Conducted through a design project. Students in a team of 2+ will be given a design project that requires to articulate and design solutions. Compliance with the design specifications needs to be given in the form of written reports. |
| 3. | Blended learning | Conducted through the Learning Management System (LMS) of NUST. All information as well as materials related to teaching and learning activities will be shared with the class through this system. Some formative assessments will be also conducted using this system. |

**Weekly Schedule:**

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| Week 1 | Introduction to distributed system - design goals, classification, and pitfalls | Steen & Tanenbaum Chap -1 |
| Week 2 | Distributed system architectures – styles, middleware and layered architectures | Steen & Tanenbaum Chap -2 |
| Week 3 | Content Addressable Networks<br>P2P Algorithms<br>Introduction to Network Simulator<br>- Explore state-of-the-art research.<br>Introduction to OMNeT++ | Internet + research paper |
| Week 4 | Need of Physical and Logical clocks<br><br>Lampert Logical Time Algorithms | Steen & Tanenbaum Chap -5 |
| Week 5 | Distributed Snapshot Algorithms | Steen & Tanenbaum Chap-8 |
| Week 6 | Mutual Exclusion<br><br>Leader selection Algorithms | Steen & Tanenbaum Chap -5 |
| Week 7 | Solr (Distributed IR simulator) | Solr |
| Week 8 | Amazon Web Services (AWS) | AWS book |
| **Week 9** | **Mid-Semester Break** | |
| Week 10 | Hadoop and Big Data | Hadoop Book |
| Week 11 | Introduction to Paxos – Distributed Consensus problem | Steen & Tanenbaum Chap-8<br>Internet resources/ research paper |
| Week 12 | Fault Tolerance | Steen & Tanenbaum Chap-8 |
| Week 13 | Introduction to Message Passing Interface | Steen & Tanenbaum Chap-4<br>Internet sources |
| Week 14 | Distributed Transactions | Steen & Tanenbaum Chap-8<br>Internet sources |
| Week 15 | Distributed File System (Google) | DFS book<br>Internet Sources |
| Week 16 | Project Presentation | |
| Week 17 | Project Presentation | |
| **Week 18** | **End Semester Exam** | |

**Assessment Methods:**

| Theory (Lecture) | | Percentage |
|---|---|---|
| 1 | Quizzes (10 marks & 20% - 5 quiz) | 10% |
| 2 | Assignments (30, 30, 40) | 10% (best of six) |
| 3 | Mid-Term Exam (60 marks) | 30% |
| 4 | End-Semester Exam (100 marks) | 50% |
| **Lab (hands on)** | | **100** |
| 5 | Labs (70%) (11-12 labs) | 70% |
| 6 | Project (30%) | 30% |
| | | **100** |

**Learning resources:**

**Textbook**

1. **M. Van Steen and A.S. Tanenbaum, Distributed Systems, 4th ed., distributed-systems.net, 2023 [request a free copy from HERE].**

**Reference Books:**

1. Distributed Systems: Concepts and Design by George Coulouris, Jean Dollimore, and Tim Kindberg, Addison Wesley, 5th edition, 2012.
2. Distributed Systems, An algorithmic approach, Sukumar Ghosh, Chapman & Hall/CRC Computer and Information Science Series, ISBN 10:1-58488-564-5
3. Parallel and distributed simulation systems, Richard Fujimoto, ISBN 0-471-18383-0
4. Any relevant book on Solr, AWS, Hadoop, and Cloud Computing
5. Research papers if required.

**Grading Policy:**

**Quiz Policy:**

The quizzes will be unannounced and normally last for ten minutes. The question framed is to test the concepts involved in the last few lectures. It is intended to conduct 5 quizzes (best of 6) - **no re-take will be permissible, however average marks can be grated based on proper excuse through UG coordinator**.

**Project Policy:**

Students will be required to develop a project during the course which should be completed towards the end of the semester. They will be graded based on project deliverables and presentation at the end. Students will work in a group/team for projects. A group of at most 3 students is recommended.

**Assignment Policy:**

In order to develop comprehensive understanding of the subject, assignments will be given. Late assignments will not be accepted / graded. All assignments will count towards the total (No 'best-of' policy). The students are advised to do the assignment themselves. Copying of assignments is highly discouraged and violations will be dealt with severely by referring any occurrences to the disciplinary committee. The questions in the assignment are meant to be challenging to give students confidence and extensive knowledge about the subject matter and enable them to prepare for the exams.

**Class participation:**

The students are encouraged to participate in class by actively taking part in asking questions from the instructor, sharing his/her thoughts about the topic under discussion, replying to instructor questions, contribute in project presentation and demo. The class participation will be recorded by the instructor and 2% of project marks are assigned to student class participation.

**Plagiarism:**

SEECS maintains a zero-tolerance policy towards plagiarism. While collaboration in this course is highly encouraged, you must ensure that you do not claim other people's work/ ideas as your own. Plagiarism occurs when the words, ideas, assertions, theories, figures, images, programming codes of others are presented as your own work. You must cite and acknowledge all sources of information in your assignments. Failing to comply with the SEECS plagiarism policy will lead to strict penalties including zero marks in assignments and referral to the academic coordination office for disciplinary action.