**University of Sana'a**
**Faculty of Engineering**
**Department of Electrical Engineering**
**Title of the Program: Computer and Control Section**

# Course Specification of Distributed & Parallel Processing

## I. Course Identification and General Information:

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Distributed & Parallel Processing | | | | |
| **2.** | Course Code & Number: | CCE325 (Elec-2) | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | - | 2 | - | 3 |
| **4.** | Study level/ semester at which this course is offered: | 4th Year – 2nd semester | | | | |
| **5.** | Pre-requisite (if any): | Programming Language 2 (C/C++) | | | | |
| **6.** | Co-requisite (if any): | None. | | | | |
| **7.** | Program(s) in which the course is offered: | Electrical Engineering – Computer and Control section | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | Location of teaching the course: | Electrical Engineering Department, Faculty of Engineering | | | | |
| **10.** | Prepared By: | Asst. Prof. Dr. Sami AL-MAQTARI | | | | |
| **11.** | Date of Approval: | | | | | |

## II. Course Description:

This is an introductory course to provide students with basic principles, fundamentals and concepts related to distributed and parallel processing, as well as their applications in online business and trading systems and complex computations systems. Topics covered in the course include: The Scope of Parallel Computing, Parallel Programming Platforms, Principles of Parallel Algorithm Design, Basic Communication Operations, Analytical Modeling of Parallel Programs, Programming Using the Message-Passing Paradigm, and Programming Shared Address Space Platforms. This course is supported with computer lab, homework and search work to develop students with knowledge and development skills on distributed and parallel processing.

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| Asst. Prof. Dr. Sami AL-MAQTARI | Asst. Prof. Dr. Adel Ahmed Al-Shakiri | Assoc. Prof. Dr. Mohammad Algorafi | Prof. Dr. Mohammed AL-Bukhaiti | Assoc. Prof. Dr. Huda Al-Emad |

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| III. Course Intended learning outcomes (CILOs) of the course | | Referenced PILOs |
|---|---|---|
| **a1** | Define the basic concepts of parallel computation. | A1, A2, A3, A4 |
| **a2** | Explain the design, testing, and performance analysis of a software system,. | |
| **b1** | Recognize the application of fundamental Computer Science methods and algorithms in the development of parallel applications | B1, B2, B3, B4 |
| **c1** | Use the parallel and distributed computing techniques and methodologies for the development of parallel processing & distributed systems. | C1, C2, C3, C4 |
| **c2** | Apply design, development, and performance analysis of parallel and distributed applications. | |
| **d1** | Function effectively individually or within teams by sharing ideas clearly. | D1, D2, D3, D4 |
| **d2** | Conduct searches on parallel-distributed solutions for engineering problems and be able to communicate that design to others. | |

**(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:**

| Course Intended Learning Outcomes | | Teaching strategies | Assessment Strategies |
|---|---|---|---|
| **a1.** | Define the basic concepts of parallel computation. | ▪ Active Lectures.<br>▪ Homework.<br>▪ Search | ▪ Written Assessment.<br>▪ Quizzes.<br>▪ Reports |
| **a2.** | Explain the design, testing, and performance analysis of a software system. | | |

**(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:**

| Course Intended Learning Outcomes | | Teaching strategies | Assessment Strategies |
|---|---|---|---|
| **b1.** | Recognize the application of fundamental Computer Science methods and algorithms in the development of parallel applications | ▪ Active Lectures.<br>▪ Laboratory Work.<br>▪ Homework.<br>▪ Search. | ▪ Written Assessment.<br>▪ Quizzes.<br>▪ Lab & Search Reports |

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| **(C) Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:** | | | |
|---|---|---|---|
| | Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **c1.** | Use the parallel and distributed computing techniques and methodologies for the development of parallel processing & distributed systems. | ▪ Active Lectures.<br>▪ Laboratory Work.<br>▪ Homework.<br>▪ Search. | ▪ Written Assessment.<br>▪ Quizzes.<br>▪ Lab Reports |
| **c2**. | Apply design, development, and performance analysis of parallel and distributed applications. | | |

| **(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:** | | | |
|---|---|---|---|
| | Course Intended Learning Outcomes | Teaching strategies | Assessment Strategies |
| **d1.** | Function effectively individually or within teams by sharing ideas clearly. | ▪ project<br>▪ Laboratory Work,<br>▪ Search,<br>▪ Self-Learning | ▪ Written Assessment.<br>▪ report.<br>▪ Presentations |
| **d2.** | Conduct searches on parallel-distributed solutions for engineering problems and be able to communicate that design to others. | | |

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## IV. Course Content:

### A. Theoretical Aspect

| Order | Units/Topics List | Learning Outcomes | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|---|
| **1.** | Introduction | a1, a2 | ▪ Motivating Parallelism.<br>▪ Scope of Parallel Computing.<br>▪ Organization and Contents of the Text.<br>▪ The concept of parallel computers and programming,<br>▪ Extension of a single processor system into a shared memory multiprocessor,<br>▪ The message-passing multiprocessor (multicomputer),<br>▪ Static interconnection networks suitable for message passing multicomputer | 1 | 2 |
| **2.** | Parallel Programming Platforms | a1, a2, b1, c1 | ▪ Implicit Parallelism.<br>▪ Limitations of Memory System Performance.<br>▪ Dichotomy of Parallel Computing Platforms.<br>▪ Physical Organization of Parallel Platforms.<br>▪ Communication Costs in Parallel Machines.<br>▪ Routing Mechanisms for Interconnection Networks.<br>▪ Impact of Process-Processor Mapping and Mapping Techniques. | 2 | 4 |

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| | | | | | |
|---|---|---|---|---|---|
| **3.** | Principles of Parallel Algorithm Design | a1, a2, b1, c1, c2 | ▪ Preliminaries: Decomposition, Tasks, and Dependency Graphs<br>▪ Decomposition Techniques.<br>▪ Characteristics of Tasks and Interactions.<br>▪ Mapping Techniques for Load Balancing.<br>▪ Methods for Containing Interaction Overheads.<br>▪ Parallel Algorithm Models. | 2 | 4 |
| **4.** | Basic Communication Operations | a1, a2, b1, c1 | ▪ One-to-All Broadcast and All-to-One Reduction.<br>▪ All-to-All Broadcast and Reduction.<br>▪ All-Reduce and Prefix-Sum Operations.<br>▪ Scatter and Gather.<br>▪ All-to-All Personalized Communication.<br>▪ Circular Shift.<br>▪ Improving the Speed of Some Communication Operations. | 2 | 4 |
| **5.** | Analytical Modeling of Parallel Programs | a1, a2, b1, c1, c2 | ▪ Sources of Overhead in Parallel Programs.<br>▪ Performance Metrics for Parallel Systems.<br>▪ The Effect of Granularity on Performance.<br>▪ Scalability of Parallel Systems.<br>▪ Minimum Execution Time and Minimum Cost-Optimal Execution Time.<br>▪ Asymptotic Analysis of Parallel Programs.<br>▪ Other Scalability Metrics. | 1 | 2 |

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| | | | | | |
|---|---|---|---|---|---|
| **6.** | Programming Using the Message-Passing Paradigm | a1, a2, b1, c1, c2 | ▪ Principles of Message-Passing Programming.<br>▪ The Building Blocks: Send and Receive Operations.<br>▪ MPI: the Message Passing Interface.<br>▪ Topologies and Embedding.<br>▪ Overlapping Communication with Computation.<br>▪ Collective Communication and Computation Operations.<br>▪ Groups and Communicators. | 2 | 4 |
| **7.** | Shared Memory Programming - Sorting Algorithms : | a1, a2, b1, c1 | ▪ Rank sort , Bubble sort, Odd-even transposition sort,<br>▪ Shear sort, Merge sort,<br>▪ Quicksort, including on a hypercube,<br>▪ Odd-even merge sort,<br>▪ Bitonic merge sort. | 1 | 2 |
| **8.** | Programming Shared Address Space Platforms | a1, a2, b1, c1, c2 | ▪ Thread Basics.<br>▪ Why Threads?<br>▪ The POSIX Thread API.<br>▪ Thread Basics: Creation and Termination.<br>▪ Synchronization Primitives in Pthreads.<br>▪ Controlling Thread and Synchronization Attributes.<br>▪ Thread Cancellation.<br>▪ Composite Synchronization Constructs.<br>▪ Tips for Designing Asynchronous Programs.<br>▪ OpenMP: a Standard for Directive Based Parallel Programming. | 2 | 4 |

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| | | | | | |
|---|---|---|---|---|---|
| **9.** | Graph Algorithms | a1, a2, b1, c1, c2 | ▪ Definitions and Representation.<br>▪ Minimum Spanning Tree: Prim's Algorithm.<br>▪ Single-Source Shortest Paths: Dijkstra's Algorithm.<br>▪ All-Pairs Shortest Paths.<br>▪ Transitive Closure.<br>▪ Connected Components.<br>▪ Algorithms for Sparse Graphs. | 1 | 2 |
| **Number of Weeks /and Units Per Semester** | | | | **14** | **28** |

## B. Practical Aspect:

| Order | Tasks/ Experiments | Number of Weeks | Contact hours | Learning Outcomes |
|---|---|---|---|---|
| **1.** | Introduction to Distributed Systems and Parallel Programming:<br>Basic Concepts and Principles and Theories,<br>Software tools and Programming Techniques,<br>Parallel Programming Platforms. | 3 | 6 | a1, a2, b1 c1 |
| **2.** | Principles of Parallel Algorithms Design and Programming | 2 | 4 | a1, a2, b1 c1, c2, d1 |
| **3.** | Analytical Modelling of parallel Programs | 2 | 4 | b1 c1, c2, d1 |
| **4.** | Programming Using the Message-Passing Paradigm | 1 | 2 | a1, a2, b1 c1, c2, d1 |
| **5.** | Shared Memory Programming - Sorting Algorithms : | 2 | 4 | b1 c1, c2, d1 |
| **6.** | Programming Shared Address Space Platforms<br>Multithreading Programming<br>Pipeline Programming | 2 | 4 | a1, a2, b1 c1, c2, d1 |
| **7.** | Graph Algorithms | 1 | 2 | a1, a2, b1 c1, c2, d1 |
| **8.** | Final Lab Exam | 1 | 2 | a1, a2, b1 c1, c2, d1 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** | |

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## V. Teaching strategies of the course:

- Lectures,
- Laboratory
- Homework
- Search,
- Self-learning

## VI. Searches & Reports:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | Search Web and Prepare Report on Distributed Systems and Parallel Programming Techniques, Tools, Platforms and Performance Measures | a1, a2, b1, c1, c2, d1, d2 | 3rd to 5th | 3 |
| **2.** | Report on Parallel Algorithms Design and Programming | b1, c1, c2, d1, d2 | 7th | 2 |
| **3.** | Report on Pipeline processing and Programming, Shared Memory Programming, Sorting Techniques and Graph | b1, c1, c2, d1, d2 | 9th to 13th | 3 |
| **4.** | Lab Reports | b1 c1, c2, d1 | 3rd to 13th | 7 |
| **Total** | | | | **15** |

## VII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment | Aligned Course Learning Outcomes |
|---|---|---|---|---|---|
| **1.** | Searches & Reports | 3rd to 13th | 15 | 10% | a1, a2, b1, c1, c2, d1 |
| **2.** | Quizzes | 4th, 10th & 14th | 10 | 6.67% | a1, a2, b1, c1 |
| **3.** | Mid-term Exam (theoretical) | 9th | 22.5 | 15% | a1, a2, b1, c1, c2 |
| **4.** | Final Exam (practical) | 14th | 22.5 | 15% | a1, a2, b1, c1, c2, d1 |

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|---|---|---|---|---|---|
| **5.** | Final Exam (theoretical) | 16th | 80 | 53.33% | a1, a2, b1, c1, c2 |
| **Total** | | | **150** | **100%** | |

## VIII. Learning Resources:

*Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) (maximum two).**

1- Ananth Grama & Anshul Gupta & George Karypis & Vipin Kumar, 2003, "Introduction to Parallel Computing", 2nd Edition, Pearson. ISBN-13: 978-0201648652
2- Peter S. Pacheco, 2011, "An Introduction to Parallel Programming", Morgan Kaufmann. ISBN-13: 978-0123742605

**2- Essential References.**

1- Vladimir Stankovic & Lina Stankovic & Shuang Wang & Samuel Cheng & Yong Fang, 2017, "Distributed Source Coding: Theory and Practice", Wiley. ISBN-13: 978-0470688991
2- Raja Malleswara Rao Pattamsetti, 2018, "Distributed Computing in Java 9: Make the best of Java for distributing applications", Packt Publishing. ISBN-13: 978-1787126992

**3- Electronic Materials and Web Sites *etc*.**

1- https://www.mcs.anl.gov/research/projects/mpi/
2- http://www.oscer.ou.edu/education.php

## IX. Course Policies:

| | |
|---|---|
| **1.** | **Class Attendance:**<br>- The students should have more than 75% of attendance according to rules and regulations of the faculty. |
| **2.** | **Tardy**:<br>- The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture. |
| **3.** | **Exam Attendance/Punctuality:**<br>- The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam. |

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| **4.** | **Assignments & Projects:**<br>- The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time. |
| **5.** | **Cheating**:<br>- If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquires. |
| **6.** | **Plagiarism**:<br>- If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university. |
| **7.** | **Other policies:**<br>- All the teaching materials should be kept out the examination hall and mobile phones are not allowed.<br>- Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university. |

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| **Reviewed By** | **Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat**<br>**President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi**<br>**Name of Reviewer from the Department: Assoc. Prof. Dr. Farouk Al-Fuhaidy** |
| | **Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa**<br>**Assoc. Prof. Dr. Ahmed Mujahed**<br>**Asst. Prof. Dr. Munasar Alsubri** |

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**Faculty of Engineering**
**Department of Electrical Engineering**
**Title of the Program: Computer and Control Section**

# Course Plan of Distributed & Parallel Processing

| I. Information about Faculty Member Responsible for the Course: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Name of Faculty Member** | Dr. Sami AL-MAQTARI | **Office Hours** | | | | | |
| **Location& Telephone No.** | 771010885 | **SAT** | **SUN** | **MON** | **TUE** | **WED** | **THU** |
| **E-mail** | dr.samiaziz@gmail.com | | | 10-12 | | | |

| II. Course Identification and General Information: | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Course Title: | Distributed & Parallel Processing | | | | |
| **2.** | Course Code & Number: | CCE325 (Elec-2) | | | | |
| **3.** | Credit hours: | C.H | | | | Total |
| | | Th. | Tu. | Pr. | Tr. | |
| | | 2 | - | 2 | - | 3 |
| **4.** | Study level/ semester at which this course is offered: | $4^{th}$ Year – $2^{nd}$ Semester | | | | |
| **5.** | Pre-requisite (if any): | Programming Language 2 (C/C++) | | | | |
| **6.** | Co-requisite (if any): | None. | | | | |
| **7.** | Program(s) in which the course is offered: | Electrical Engineering – Computer and Control section | | | | |
| **8.** | Language of teaching the course: | English | | | | |
| **9.** | System of Study: | Semesters | | | | |
| **10.** | Mode of delivery: | Lecture | | | | |
| **11.** | Location of teaching the course: | Electrical Engineering Department, Faculty of Engineering | | | | |

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## III. Course Description:

This is an introductory course to provide students with basic principles, fundamentals and concepts related to distributed and parallel processing, as well as their applications in online business and trading systems and complex computations systems. Topics covered in the course include: The Scope of Parallel Computing, Parallel Programming Platforms, Principles of Parallel Algorithm Design, Basic Communication Operations, Analytical Modeling of Parallel Programs, Programming Using the Message-Passing Paradigm, and Programming Shared Address Space Platforms. This course is supported with computer lab, homework and search work to develop students with knowledge and development skills on distributed and parallel processing.

## IV. Intended learning outcomes (ILOs) of the course:

Brief summary of the knowledge or skill the course is intended to develop:

1. Define the basic concepts of parallel computation.
2. Explain the design, testing, and performance analysis of a software system,.
3. Recognize the application of fundamental Computer Science methods and algorithms in the development of parallel applications
4. Use the parallel and distributed computing techniques and methodologies for the development of parallel processing & distributed systems.
5. Apply design, development, and performance analysis of parallel and distributed applications.
6. Function effectively individually or within teams by sharing ideas clearly.
7. Conduct searches on parallel-distributed solutions for engineering problems and be able to communicate that design to others.

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## V. Course Content:

### A. Theoretical Aspect

| Order | Units/Topics List | Sub Topics List | Number of Weeks | Contact hours |
|---|---|---|---|---|
| **1.** | Introduction | ▪ Motivating Parallelism.<br>▪ Scope of Parallel Computing.<br>▪ Organization and Contents of the Text.<br>▪ The concept of parallel computers and programming,<br>▪ Extension of a single processor system into a shared memory multiprocessor,<br>▪ The message-passing multiprocessor (multicomputer),<br>▪ Static interconnection networks suitable for message passing multicomputer | 1st | 2 |
| **2.** | Parallel Programming Platforms | ▪ Implicit Parallelism.<br>▪ Limitations of Memory System Performance.<br>▪ Dichotomy of Parallel Computing Platforms.<br>▪ Physical Organization of Parallel Platforms.<br>▪ Communication Costs in Parallel Machines.<br>▪ Routing Mechanisms for Interconnection Networks.<br>▪ Impact of Process-Processor Mapping and Mapping Techniques. | 2nd ,3rd | 4 |
| **3.** | Principles of Parallel Algorithm Design | ▪ Preliminaries: Decomposition, Tasks, and Dependency Graphs<br>▪ Decomposition Techniques.<br>▪ Characteristics of Tasks and Interactions.<br>▪ Mapping Techniques for Load Balancing.<br>▪ Methods for Containing Interaction Overheads.<br>▪ Parallel Algorithm Models. | 4th ,5th | 4 |

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|---|---|---|---|---|
| **4.** | Basic Communication Operations | ▪ One-to-All Broadcast and All-to-One Reduction.<br>▪ All-to-All Broadcast and Reduction.<br>▪ All-Reduce and Prefix-Sum Operations.<br>▪ Scatter and Gather.<br>▪ All-to-All Personalized Communication.<br>▪ Circular Shift.<br>▪ Improving the Speed of Some Communication Operations. | $6^{th}$ ,$7^{th}$ | 4 |
| **5.** | Analytical Modeling of Parallel Programs | ▪ Sources of Overhead in Parallel Programs.<br>▪ Performance Metrics for Parallel Systems.<br>▪ The Effect of Granularity on Performance.<br>▪ Scalability of Parallel Systems.<br>▪ Minimum Execution Time and Minimum Cost-Optimal Execution Time.<br>▪ Asymptotic Analysis of Parallel Programs.<br>▪ Other Scalability Metrics. | $8^{th}$ | 2 |
| **6.** | Mid-term Exam | ▪ ALL Previous Topics | $9^{th}$ | 2 |
| **7.** | Programming Using the Message-Passing Paradigm | ▪ Principles of Message-Passing Programming.<br>▪ The Building Blocks: Send and Receive Operations.<br>▪ MPI: the Message Passing Interface.<br>▪ Topologies and Embedding.<br>▪ Overlapping Communication with Computation.<br>▪ Collective Communication and Computation Operations.<br>▪ Groups and Communicators. | $10^{th}$ ,$11^{th}$ | 4 |
| **8.** | Shared Memory Programming - Sorting Algorithms : | ▪ Rank sort , Bubble sort, Odd-even transposition sort,<br>▪ Shear sort, Merge sort,<br>▪ Quicksort, including on a hypercube,<br>▪ Odd-even merge sort,<br>▪ Bitonic merge sort. | $12^{th}$ | 2 |

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|---|---|---|---|---|
| **9.** | Programming Shared Address Space Platforms | ▪ Thread Basics.<br>▪ Why Threads?<br>▪ The POSIX Thread API.<br>▪ Thread Basics: Creation and Termination.<br>▪ Synchronization Primitives in Pthreads.<br>▪ Controlling Thread and Synchronization Attributes.<br>▪ Thread Cancellation.<br>▪ Composite Synchronization Constructs.<br>▪ Tips for Designing Asynchronous Programs.<br>▪ OpenMP: a Standard for Directive Based Parallel Programming. | 13th ,14th | 4 |
| **10.** | Graph Algorithms | ▪ Definitions and Representation.<br>▪ Minimum Spanning Tree: Prim's Algorithm.<br>▪ Single-Source Shortest Paths: Dijkstra's Algorithm.<br>▪ All-Pairs Shortest Paths.<br>▪ Transitive Closure.<br>▪ Connected Components.<br>▪ Algorithms for Sparse Graphs. | 15th | 2 |
| **11.** | Final Exam | ▪ ALL Topics | 16th | 2 |
| **Number of Weeks /and Units Per Semester** | | | **16** | **32** |

## B. Practical Aspect:

| Order | Tasks/ Experiments | Number of Weeks | Contact hours |
|---|---|---|---|
| **1.** | Introduction to Distributed Systems and Parallel Programming:<br>Basic Concepts and Principles and Theories,<br>Software tools and Programming Techniques,<br>Parallel Programming Platforms. | 1st ,2nd ,3rd | 6 |
| **2.** | Principles of Parallel Algorithms Design and Programming | 4th ,5th | 4 |
| **3.** | Analytical Modelling of parallel Programs | 6th ,7th | 4 |

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| | | | |
|---|---|---|---|
| **4.** | Programming Using the Message-Passing Paradigm | 8th | 2 |
| **5.** | Shared Memory Programming - Sorting Algorithms : | 9th ,10th | 4 |
| **6.** | Programming Shared Address Space Platforms<br>Multithreading Programming<br>Pipeline Programming | 11th ,12th | 4 |
| **7.** | Graph Algorithms | 13th | 2 |
| **8.** | Final Lab Exam | 14th | 2 |
| **Number of Weeks /and Units Per Semester** | | **14** | **28** |

## VI. Teaching strategies of the course:

- Lectures,
- Laboratory
- Homework
- Search,
- Self-learning

## VII. Searches & Reports:

| No | Assignments | Aligned CILOs(symbols) | Week Due | Mark |
|---|---|---|---|---|
| **1.** | Search Web and Prepare Report on Distributed Systems and Parallel Programming Techniques, Tools, Platforms and Performance Measures | a1, a2, b1, c1, c2, d1, d2 | 3rd to 5th | 3 |
| **2.** | Report on Parallel Algorithms Design and Programming | b1, c1, c2, d1, d2 | 7th | 2 |
| **3.** | Report on Pipeline processing and Programming, Shared Memory Programming, Sorting Techniques and Graph | b1, c1, c2, d1, d2 | 9th to 13th | 3 |
| **4.** | Lab Reports | b1 c1, c2, d1 | 3rd to 13th | 7 |
| **Total** | | | | **15** |

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## VIII. Schedule of Assessment Tasks for Students During the Semester:

| No. | Assessment Method | Week Due | Mark | Proportion of Final Assessment |
|---|---|---|---|---|
| **1.** | Searches & Reports | 3rd to 13th | 15 | 10% |
| **2.** | Quizzes | 4th, 10th & 14th | 10 | 6.67% |
| **3.** | Mid-term Exam (theoretical) | 9th | 22.5 | 15% |
| **4.** | Final Exam (practical) | 14th | 22.5 | 15% |
| **5.** | Final Exam (theoretical) | 16th | 80 | 53.33% |
| **Total** | | | **150** | **100%** |

## IX. Learning Resources:

*Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

**1- Required Textbook(s) (maximum two).**

1. Ananth Grama & Anshul Gupta & George Karypis & Vipin Kumar, 2003, "Introduction to Parallel Computing", 2nd Edition, Pearson. ISBN-13: 978-0201648652
2. Peter S. Pacheco, 2011, "An Introduction to Parallel Programming", Morgan Kaufmann. ISBN-13: 978-0123742605

**2- Essential References.**

1. Vladimir Stankovic & Lina Stankovic & Shuang Wang & Samuel Cheng & Yong Fang, 2017, "Distributed Source Coding: Theory and Practice", Wiley. ISBN-13: 978-0470688991
2. Raja Malleswara Rao Pattamsetti, 2018, "Distributed Computing in Java 9: Make the best of Java for distributing applications", Packt Publishing. ISBN-13: 978-1787126992

**3- Electronic Materials and Web Sites *etc*.**

1. https://www.mcs.anl.gov/research/projects/mpi/
2. http://www.oscer.ou.edu/education.php

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## X. Course Policies:

| | |
|---|---|
| **1.** | **Class Attendance:**<br>- The students should have more than 75% of attendance according to rules and regulations of the faculty. |
| **2.** | **Tardy**:<br>- The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture. |
| **3.** | **Exam Attendance/Punctuality:**<br>- The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam. |
| **4.** | **Assignments & Projects:**<br>- The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time. |
| **5.** | **Cheating**:<br>- If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquires. |
| **6.** | **Plagiarism**:<br>- If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university. |
| **7.** | **Other policies:**<br>- All the teaching materials should be kept out the examination hall and mobile phones are not allowed.<br>- Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university. |

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