American University of Ras Al Khaimah

AURAK Syllabus

Course & Instructor Information

Course Title: Introduction to Parallel Programming

Course Code: CSCI 415

Credit Hours: 3.0

Methods of Instruction *(See Syllabus Guide for additional information that should be added here):*

This course is taught using the face-to-face method of instruction. This class is lecture with out-of-class activities such as assignments and in class activities such as quizzes.

Prerequisite course(s) and/or co-requisite courses, if applicable:

Course Prerequisite: (Course : CSCI 215)

Faculty Name: Khaled Abdelgader Balawafi

Contact Information and Office Hours:

khaled.balawafi@aurak.ac.ae -Monday & Wednesday from 10:30 am to 12:0 pm.

Course Description:

This course is an introduction to parallel programming principles and techniques. Topics include parallel computing memory architecture, memory organization, parallel programming models, parallel program design, performance evaluation, thread-based parallelism, process-based parallelism, message passing, asynchronous programming, and heterogeneous programming.

Additional Information about the course:

This course is NOT an online course. In this course students will be introduced to parallel programming principles and techniques.

Course Textbooks and Materials:

- Subodh Kumar. (2023). Introduction to Parallel Programming. Cambridge University Press. ISBN-13: lrm 978-1009069533.
- Giancarlo Zaccone. Python Parallel Programming Cookbook, 2nd Edition, 2019, ISBN-13: 978-1789533736.
- Brian Tuomanen. Hands-On GPU Programming with Python and CUDA. 2018, Packt Publishing. ISBN-13: lrm 978-1788993913.

Other Resources:

- Notes and Handouts by instructor.
- Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, “Introduction to Parallel Computing,” 2nd Edition, 2003, Pearson, ISBN-13: 978-0201648652.

Web Resources:

https://documen.tician.de/pycuda/tutorial.html

Course Learning Outcomes (CLOs)

Course Learning Outcomes **At the end of this course, students should be able to:**	
CLO 1	Apply various basic concepts associated with parallel computing environments.
CLO 2	Demonstrate the trade-offs involved in the different types of parallel programming architecture, memory organization, parallel programming models, and parallel program design.
CLO 3	Compare several different parallel computing paradigms such as thread-based parallelism, process-based parallelism, message passing, asynchronous programming, and heterogeneous programming.
CLO 4	Examine the performance of parallel programs and implement parallel computing solutions.

Program Learning Outcomes (PLOs) and Mapping Course to Program Outcomes

Please see the APPENDIX for the Course to Program Learning Outcomes Mapping.

Assessment Activities

The dates for quizzes, exams, and submission of assignments are specified in the schedule. You will be graded in this class based on the number of points you earn for quizzes, exams written assignments, or other activities, including your class participation. Keep track of your scores in Blackboard.

Assessment Activities and Grading Weight	Course Activities / Assignments 10%	Quizzes 20%	Midterm Exam 25%	Team Project 10%	Final Exam 35%
CLO 1			X		X
CLO 2	X	X	X	X	X
CLO 3	X	X	X	X	X
CLO 4	X	X		X	

Grading Scale

The grading system and scale for AURAK, as established by the Board of Trustees, is as follows:

AURAK Grading System and Scale		
Grade	**Percentage Scores**	**Grade Points**
A	95-100	4.00
A-	90-94	3.70
B+	86-89	3.30
B	83-85	3.00
B-	80-82	2.70
C+	76-79	2.30
C	73-75	2.00
C-	70-72	1.70
D+	66-69	1.30
D	60-65	1.00

F	0-59	0.00

An “S” grade reflects satisfactory, or passing, work in a course (i.e., equivalent to grade of C or higher for graduate students. A “U” grade reflects unsatisfactory, or failing, work in a course. S/U will have no effect on the GPA.

Weekly Course Information

Schedule of Course Topics, Required Reading, and Assignments and Assessments				
Week	Topic	Required Readings	Assignment, Assessment (with grade weighting) & Due Date	Mapping of CLOs to Assessments
1	Introduction, Flynn's Taxonomy and Memory Organization	Textbook Chapter 1		
2	Parallel Programming Models & Performance Evaluation of a Parallel Program	Textbook Chapter 1		
3	Introducing Python Programming	Textbook Chapter 1		
4	Thread-based Parallelism: Thread initialization, synchronization with lock and semaphores	Textbook Chapter 1		
5	Thread-based Parallelism: Thread initialization, synchronization with condition, event, barrier, and queue	Textbook Chapter 2	Quiz #1 – 10% 24/9/2025	CLO 2
6	Process-based Parallelism: Process spawning, queuing, and pipelining	Textbook Chapter 2	Assignment – 10% 3/10/2025	CLO 2, 3
7	Process-based Parallelism: Process synchronization and process pool	Textbook Chapter 3		
8	Message Passing: Point-to-point communication and deadlock prevention	Textbook Chapter 3	Midterm Exam – 25% 13/10/2025	CLO 1, 2, 3
9	Message Passing: Collective communication using broadcast, scatter, and gather function	Textbook Chapter 4		
10	Asynchronous Programming: Concurrency	Textbook Chapter 4		
11	Asynchronous Programming: Concurrency Scheduler	Textbook Chapter 5	Quiz #2 - 10% 5/11/2025	CLO 3, 4

12	Heterogeneous Computing: GPU architecture and programming	Textbook Chapter 5		
13	Heterogeneous Computing: Basic PyCUDA	Textbook Chapter 8		
14		Textbook Chapter 8	Team Project – 10% 24-26/11/2025	CLO 2, 3, 4
15	Debugging and Testing Parallel Programs	Textbook Chapter 9		
16	**Final Exam**		Final Exam – 35%	CLO 1, 2, 3

Attendance Policy

Regular student attendance and class participation are essential for students to meet course expectations and to succeed in their studies. The following are benefits associated with attending classes:

- Opportunity to participate in active learning
- Opportunity to demonstrate preparation for class
- Opportunity to engage with the faculty member teaching the course, classmates, and the course material.

The following are requirements of the university's attendance policy:

- Students must provide a satisfactory reason for being absent from class, to the course instructor and the Student Life Departent, in advance of missing a class.
- Students must observe protocols for online course attendance (e.g., having camera turned on).

- Students must arrive on time for class and must not depart early from the class. Persistent late arrival at, or early departure from, class meetings may result in being counted as absent from class.

If students fail to attend 20% of the scheduled classes for the semester *without a valid excuse*, they will be withdrawn from the course with a grade of either W or F depending on when the 20% unexcused absence level is reached.

The total number of *unexcused and excused absences* cannot exceed 30% of the class meetings for the course, with unexcused absences not exceeding 20%. Students who miss more than 30% of the scheduled classes will be withdrawn from the course with a grade of either W or F depending on when the 30% absence level is reached.

Please refer to the Student Handbook for details.

Accommodations for Students of Determination

Students of determination may find they require additional support, services, or considerations. AURAK will endeavor to support students of determination of those with special needs where resources are available. Accommodations will be provided, for students with verified needs, allowing equal access to educational facilities, programs, services, and activities at AURAK. Accommodations are never applied retroactively – only students who have previously requested and have been approved for supporting accommodations can have them apply to a given academic semester/course. Students needing support must make the request from the Office of Support Services located in Building D.

Other Relevant Policies

A. Academic Integrity

The Honor Code

The American University of Ras Al Khaimah strongly supports the concept of academic integrity and expects students and all other members of the AURAK community to be honest in all academic endeavors. The AURAK Honor Code can be found in the AURAK Student Handbook.

The role of the Honor Code and associated Academic Integrity Policy is to protect the academic integrity of the university, encourage consistent ethical behavior among students, and foster a climate of honorable academic

achievement. The Honor Code is an integral part of university life and students are responsible, therefore, for understanding and abiding by the code's provisions. While a student's commitment to honesty and personal integrity is assumed and expected, this Code and associated policy and procedures provides clarity of expectations.

Expectations

Cheating, plagiarism, and all other forms of academic fraud are unacceptable; they are serious violations of university policy. AURAK expects all students to be familiar with university policies on academic integrity. The university will not accept a claim of ignorance – either of the policy itself or of what constitutes academic fraud – as a valid defense against such a charge.

Violations of Academic Integrity

Violations of academic integrity constitute academic fraud. Academic fraud consists of any actions that serves to undermine the integrity of the academic process or that gives the student an unfair advantage, including:

- Inspecting, duplicating or distributing test materials without authorization.
- Cheating, attempting to cheat, or assisting others to cheat – relevant here is the prohibition on being in possession of a mobile telephone or similar electronic device during a test or examination. In case such devices are found with a student, the student will be deemed to have attempted to cheat and will be subject to disciplinary action under the Student Academic Integrity Policy.
- Altering work after it has been submitted for a grade.
- Plagiarizing.
- Using or attempting to use anything that constitutes unauthorized assistance. ***PLEASE NOTE***: Faculty members may prohibit the use of generative AI, including though not limited to, generative AI such as Open AI ChatGPT and Canva, in completing assignments. When such prohibitions have been communicated by the faculty member, incorporating information from such sources into your assignment submission will be treated as a serious violation of academic integrity expectations.
- Fabricating, falsifying, distorting, or inventing any information, documentation, or citation.

Plagiarism

One of the most common violations of academic integrity is plagiarism. Plagiarism can be intentional or unintentional. However, since each student is responsible for knowing what constitutes plagiarism, unintentional plagiarism is as unacceptable as intentional plagiarism and thus will bring the same penalties.

Plagiarism – submitting the work of others as one's own - is a serious offense. This includes submitting work obtained from AI writers such as Open AI Chat GPT, as well as other forms of generative AI. In the academic world, plagiarism is theft. Information from sources – whether quoted, paraphrased, or summarized – must be given credit through specific citations. When a student paraphrases a work, it is still necessary to cite the original source, even when the information has been provided by generative AI writers and/or sources. Merely rearranging a sentence or changing a few words is not sufficient. The citation style should be appropriate for the discipline and should clearly indicate the beginning and ending of the referenced material. All sources used in the preparation of an academic paper must also be listed with full bibliographic details at the end of the paper, as appropriate in the discipline. ***PLEASE NOTE:*** Faculty members may prohibit the use of generative AI in completing assignments. When such prohibitions have been communicated by the faculty member, incorporating information from such sources into your assignment submission will be treated as a serious violation of academic integrity expectations.

While plagiarism detection software can assist identifying plagiarism, there is no "percentage of matching content" threshold for determining that content in a written assignment has been plagiarized. Indeed, the presentation of a single striking phrase originally written by another without attribution to the original source can constitute plagiarism, even though the percentage of matching content found by plagiarism-checking software might be very small.

Faculty and Student Expectations

- Every student, faculty member, and administrator is responsible for upholding the highest standards of academic integrity. Every member of the AURAK community shall honor the spirit of this policy by refusing to tolerate academic fraud.

- It is the responsibility of the instructor to provide students with additional guidelines for what constitutes "authorized" and "unauthorized" assistance.

- It is the responsibility of every student to see clarification if in doubt about what constitutes 'authorized" and "unauthorized" assistance. In cases involving collaborative work, all students within the collaborative group may be help responsible for violating the code if any member of the group receives, accepts, or utilizes "unauthorized" assistance.

- Students are required to obtain permission prior to submitting work, any part of which was previously or will be submitted in another course. The instructor has the option of accepting, rejecting, or requiring modification of the content of previously or simultaneously submitted work.

A student who suspects that a violation of academic integrity has occurred should report the violation to the dean or to the Office of the Provost. In this report, the student should describe any action taken, such as talking with the person involved or with a faculty or staff member. Every effort will be made to preserve the anonymity of the student reporting the incident;

Possible penalties for academic fraud include: Formal warning, Reduction in grade for the assignment, Reduction in the grade for the course, A failing grade for the assignment, A failing grade (F) in the course, and/or Dismissal or Expulsion from the University.

Please refer to the relevant section in the *Student Handbook* and ensure a clear understanding of the provisions of the University Honor Code and the Student Academic Integrity Policy.

B. Concerns about grades or other course matters.

Students are responsible for their learning experiences. If you are concerned about a class matter, first discuss it with the instructor. If the matter is not resolved, the next step is to meet with the Chair of the department in which the course is taught. If you still have a concern, meet with the Dean of the school in which the course is taught. The matter is likely to be resolved before it reaches that point, but if it is not, then visit the Associate Provost for Academic Affairs. Students who decide to “jump to the top” will be referred “back” to the appropriate next step.

C. Assignments

University policy is that assignments are due on the date indicated when the assignment is made. Instructors may refuse to accept late assignments or lower the grade that would be otherwise given.

D. Mobile Phones

All mobile phones and other communication devices should be turned off before entering the classroom. Students may NOT have mobile telephone or other electronic devices in their possession while completing examinations. Any violation will be deemed as having attempted to cheat.

E. Diversity and the Use of English

English is the common language of the AURAK campus for everyone. It is the only language to be used in the classroom. AURAK brings together students and faculty from diverse cultural and linguistic backgrounds, which is one of the strengths of the university. This diversity provides an opportunity to share our different experiences and enlarge our understanding of the world.

APPENDIX

Program Learning Outcomes (PLOs) : BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

Program Learning Outcomes **At the completion of the program, students should be able to:**	
PLO 1	1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
PLO 2	2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
PLO 3	3. An ability to communicate effectively with a range of audiences.
PLO 4	4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
PLO 5	5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
PLO 6	6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
PLO 7	7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Mapping Course to Program Learning Outcomes : BACHELOR OF SCIENCE IN COMPUTER ENGINEERING

The learning outcomes of this course contribute to meeting one or more of the program learning outcomes as shown below, with the contribution designated as “high”, “medium”, or “low”:

	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**
CLO 1	*low*						
CLO 2	*low*						
CLO 3	*low*						
CLO 4	*high*						

Program Learning Outcomes (PLOs) : BACHELOR OF SCIENCE IN COMPUTER SCIENCE

Program Learning Outcomes

At the completion of the program, students should be able to:	
PLO 1	1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
PLO 2	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.
PLO 3	3. Communicate effectively in a variety of professional contexts.
PLO 4	4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
PLO 5	5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
PLO 6	6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

Mapping Course to Program Learning Outcomes : BACHELOR OF SCIENCE IN COMPUTER SCIENCE

The learning outcomes of this course contribute to meeting one or more of the program learning outcomes as shown below, with the contribution designated as "high", "medium", or "low":						
	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**
CLO 1	*low*					
CLO 2	*low*					
CLO 3	*low*					
CLO 4	*high*	*low*				

Program Learning Outcomes (PLOs) : BS IN ARTIFICIAL INTELLIGENCE

Program Learning Outcomes At the completion of the program, students should be able to:	
PLO 1	PLO 1. Analyze a complex computing problem and to apply principles of computing, artificial intelligence, statistics, and other relevant disciplines to identify solutions.
PLO 2	PLO 2. Design, implement, and evaluate computer science or artificial intelligence solutions to meet a given set of computing requirements in the context of the program's discipline.
PLO 3	PLO 3. Communicate effectively in a variety of professional contexts.
PLO 4	PLO 4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
PLO 5	PLO 5. Function effectively as a member or leader of a team engaged in activities appropriate to the

	program's discipline.
PLO 6	PLO 6. Apply computer science, artificial intelligence, or data science theory and software development fundamentals to produce computing-based solutions.
PLO 7	PLO 7. Build, apply, and evaluate data science models to solve problems in real world context.

Mapping Course to Program Learning Outcomes : BS IN ARTIFICIAL INTELLIGENCE

The learning outcomes of this course contribute to meeting one or more of the program learning outcomes as shown below, with the contribution designated as "high", "medium", or "low":

	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7
CLO 1	*low*						
CLO 2	*low*						
CLO 3	*low*						
CLO 4	*high*	*low*					

Mapping ABET Standards and Course Learning Outcomes to Program Learning Outcomes

ABET Standards (1-7)	*Program Learning Outcomes*	*Program Learning Outcomes Addressed in Course*
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	X
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.	
3	An ability to communicate effectively with a range of audiences.	
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.	
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	

7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	

ABET Standards (1-6)	*Program Learning Outcomes*	*Program Learning Outcomes Addressed in Course*
1	Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.	X
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.	X
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.	

PLOs (1-7)	*Program Learning Outcomes (Based on ABET's CAC)*	*Program Learning Outcomes Addressed in Course*
1	Analyze a complex computing problem and to apply principles of computing, artificial intelligence, statistics, and other relevant disciplines to identify solutions.	X
2	Design, implement, and evaluate computer science or artificial intelligence solutions to meet a given set of computing requirements in the context of the program's discipline.	X
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 and artificial intelligence theory and software development fundamentals to produce computing-based solutions.	
7	Build, apply, and evaluate data science models to solve problems using theoretical fundamentals.	