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| For Academic Affairs and Research Use Only |
| Proposal Number |  |
| CIP Code:  |  |
| Degree Code: |  |

**New or Modified Course Proposal Form**

**[ ] Undergraduate Curriculum Council**

**[X] Graduate Council**

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| **[X]New Course, [ ]Experimental Course (1-time offering), or [ ]Modified Course (Check one box)** |

Signed paper copies of proposals submitted for consideration are no longer required. Please type approver name and enter date of approval.

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| Hai Jiang 2/1/2022**Department Curriculum Committee Chair** | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Enter date…**COPE Chair (if applicable)** |
| Christos Grecos 3/4/2022**Department Chair** | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Enter date…**Head of Unit (if applicable)**   |
| Brandon Kemp 3/4/2022**College Curriculum Committee Chair** | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Enter date…**Undergraduate Curriculum Council Chair** |
| Mary Elizabeth Spence 3/7/2022**Office of Assessment (new courses only)** | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Enter date…**Graduate Curriculum Committee Chair** |
| Abhijit Bhattacharyya 3/4/2022**College Dean** | Alan Utter 3/31/2022**Vice Chancellor for Academic Affairs** |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Enter date…**General Education Committee Chair (if applicable)**   |  |

1. **Contact Person (Name, Email Address, Phone Number)**

Hai Jiang, hjiang@astate.edu, 870-680-8164

1. **Proposed starting term and Bulletin year for new course or modification to take effect**

Spring, 2023

**Instructions:**

*Please complete all sections unless otherwise noted. For course modifications, sections with a “Modification requested?” prompt need not be completed if the answer is “No.”*

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|  | **Current (Course Modifications Only)** | **Proposed (New or Modified)** *(Indicate “N/A” if no modification)* |
| **Prefix** |  | **CS** |
| **Number\*** |  | **6273** |
| **Title** (include a short title that’s 30 characters or fewer) |  | **Quantum Computing** |
| **Description\*\*** |  | A comprehensive overview of quantum computing ecosystem, covering quantum mechanics, circuits, architecture, information, algorithms, languages, programming, cryptography, hardware and killer applications. |

 ***\**** Confirm with the Registrar’s Office that number chosen has not been used before and is available for use. For variable credit courses, indicate variable range. *Proposed number for experimental course is 9*.

\*\*Forty words or fewer (excepting prerequisites and other restrictions) as it should appear in the Bulletin.

1. **Proposed prerequisites and major restrictions** **[Modification requested? Yes/No]**

(Indicate all prerequisites. If this course is restricted to a specific major, which major. If a student does not have the prerequisites or does not have the appropriate major, the student will not be allowed to register).

1. **Yes / No** Are there any prerequisites? Yes
	1. If yes, which ones?

Prerequisites, CS 3113 or “B” or better in CS 5032, and CS 3223.

* 1. Why or why not?

 Basic computer software and hardware background.

1. **Yes / No** Is this course restricted to a specific major? No
	1. If yes, which major? Enter text...
2. **Proposed course frequency [Modification requested? Yes/No]**

(e.g. Fall, Spring, Summer; if irregularly offered, please indicate, “irregular.”) *Not applicable to Graduate courses.*

Not applicable

1. **Proposed course type [Modification requested? Yes/No]**

Will this course be lecture only, lab only, lecture and lab, activity (e.g., physical education), dissertation/thesis, capstone, independent study, internship/practicum, seminar, special topics, or studio? Please choose one.

Lecture only

1. **Proposed grade type [Modification requested? Yes/No]**

What is the grade type (i.e. standard letter, credit/no credit, pass/fail, no grade, developmental, or other [please elaborate])

Standard Letter

1. **Yes / No** Is this course dual-listed (undergraduate/graduate)? No
2. **Yes / No** Is this course cross-listed? No

*(If it is, all course entries must be identical including course descriptions. Submit appropriate documentation for requested changes. It is important to check the course description of an existing course when adding a new cross-listed course.)*

**a.** – If yes, please list the prefix and course number of the cross-listed course.

 Enter text...

 **b.** – **Yes / No** Can the cross-listed course be used to satisfy the prerequisite or degree requirements this course satisfies? No

 Enter text...

1. **Yes / No** Is this course in support of a new program? No

a. If yes, what program?

 Enter text...

1. **Yes / No** Will this course be a one-to-one equivalent to a deleted course or previous version of this course (please check with the Registrar if unsure)? No

a. If yes, which course?

Enter text...

**Course Details**

1. **Proposed outline** **[Modification requested? Yes/No]**

(The course outline should be topical by weeks and should be sufficient in detail to allow for judgment of the content of the course.)

Week 1: Complex Numbers

Week 2: Complex Vector Space

Week 3: Basic Quantum Mechanics

Week 4: Quantum Gates and Circuits

Week 5: Quantum Architecture

Week 6: Quantum Entanglement

Week 7: Quantum Algorithms

Week 8: Quantum Programming Languages

Week 9: Quantum Programming

Week 10: Theoretical Computer Science

Week 11: Quantum Cryptography

Week 12: Quantum Information Theory

Week 13: Quantum Hardware

Week 14: Quantum Error Correction

Week 15: Quantum Killer Applications

1. **Proposed special features** **[Modification requested? Yes/No]**

(e.g. labs, exhibits, site visitations, etc.)

No

1. **Department staffing and classroom/lab resources**

No

1. Will this require additional faculty, supplies, etc.?

 No

1. **Yes / No** Does this course require course fees? No

 *If yes: please attach the New Program Tuition and Fees form, which is available from the UCC website.*

**Justification**

**Modification Justification (Course Modifications Only)**

1. Justification for Modification(s)

Enter text...

**New Course Justification (New Courses Only)**

1. Justification for course. Must include:

 a. Academic rationale and goals for the course (skills or level of knowledge students can be expected to attain)

 Quantum computing is an emerging branch in computer science. It integrates physics, mathematics, information theory and computer science. Students will gain knowledge about this cutting-edge computing platform.

b. How does the course fit with the mission of the department? If course is mandated by an accrediting or certifying agency, include the directive.

 Computer Science Department has offered a graduate certificate for High Performance Computing. This new course will cover a new aspect and strengthen the certificate.

c. Student population served.

Graduate students.

d. Rationale for the level of the course (lower, upper, or graduate).

Students should have comprehensive understanding about computer systems and the sophisticated hardware structure concepts as well as programming skills.

**Assessment**

**Assessment Plan Modifications (Course Modifications Only)**

1. **Yes / No** Do the proposed modifications result in a change to the assessment plan? No

 *If yes, please complete the Assessment section of the proposal*

**Relationship with Current Program-Level Assessment Process (Course modifications skip this section unless the answer to #18 is “Yes”)**

1. What is/are the intended program-level learning outcome/s for students enrolled in this course? Where will this course fit into an already existing program assessment process?
2. M.S. Computer Science graduate students should have a deeper understanding of the theory and application of algorithms, programming languages, and computer processes.
3. M.S. Computer Science graduate students should have the ability to apply advanced analysis techniques to problem identification and solution in computing applications.
4. M.S. Computer Science graduate students should have the ability to apply advanced implementation techniques to problem identification and solution in computing applications.

The course will be assessed along with other graduate courses on the same schedule.

1. Considering the indicated program-level learning outcome/s (from question #19), please fill out the following table to show how and where this course fits into the program’s continuous improvement assessment process.

*For further assistance, please see the ‘Expanded Instructions’ document available on the UCC - Forms website for guidance, or contact the Office of Assessment at 870-972-2989.*

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| **Program-Level Outcome 1 (from question #19)** | M.S. Computer Science graduate students should have a deeper understanding of the theory and application of algorithms, programming languages, and computer processes. |
| Assessment Measure | Comprehensive examinations and employer surveys |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

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| **Program-Level Outcome 2 (from question #19)** | M.S. Computer Science graduate students should have the ability to apply advanced analysis techniques to problem identification and solution in computing applications. |
| Assessment Measure | Comprehensive examinations and employer surveys |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |
| **Program-Level Outcome 3 (from question #19)** | M.S. Computer Science graduate students should have the ability to apply advanced implementation techniques to problem identification and solution in computing applications. |
| Assessment Measure | Comprehensive examinations and employer surveys |
| Assessment Timetable | Comprehensive exams will be conducted each semester, reviewed annually, and reported on every three years; employer surveys will be conducted each fall and reported on every four years. |
| Who is responsible for assessing and reporting on the results? | Department assessment committee |

*(Repeat if this new course will support additional program-level outcomes)*

 **Course-Level Outcomes**

1. What are the course-level outcomes for students enrolled in this course and the associated assessment measures?

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| **Outcome 1** | Acquire major math skills such as linear algebra, complex numbers and complex vector space |
| Which learning activities are responsible for this outcome? | Course readings and viewings, discussions, and assignments |
| Assessment Measure  | Exam questions and term projects |

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| **Outcome 2** | Understand the basic quantum mechanics |
| Which learning activities are responsible for this outcome? | Course readings and viewings, discussions, and assignments |
| Assessment Measure  | Exam questions and term projects |

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| **Outcome 3** | Examine the major quantum computing features such as superposition and entanglement. |
| Which learning activities are responsible for this outcome? | Course readings and viewings, discussions, and assignments |
| Assessment Measure  | Exam questions and term projects |

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| **Outcome 4** | Learn quantum gates, circuits, architecture and hardware |
| Which learning activities are responsible for this outcome? | Course readings and viewings, discussions, and assignments |
| Assessment Measure  | Exam questions and term projects |

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| **Outcome 5** | Develop quantum computing programming skills |
| Which learning activities are responsible for this outcome? | Course readings and viewings, discussions, and assignments |
| Assessment Measure  | Exam questions and term projects |

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| **Outcome 6** | Analyze quantum cryptographic algorithms |
| Which learning activities are responsible for this outcome? | Course readings and viewings, discussions, and assignments |
| Assessment Measure  | Exam questions and term projects |

**Bulletin Changes**

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| **Instructions**  |
| **Please visit** [**http://www.astate.edu/a/registrar/students/bulletins/index.dot**](http://www.astate.edu/a/registrar/students/bulletins/index.dot) **and select the most recent version of the bulletin. Copy and paste all bulletin pages this proposal affects below. Please include a before (with changed areas highlighted) and after of all affected sections.** **\*Please note: Courses are often listed in multiple sections of the bulletin. To ensure that all affected sections have been located, please search the bulletin (ctrl+F) for the appropriate courses before submission of this form.**  |

**CS 6263. Cloud Computing** Major aspects of the cloud ecosystem including conceptual basis, design, virtualization, architecture, storage, programming paradigms, and software development. Prerequisites, CS 3113 or “B” or better in CS 5032, and CS 3233.

**CS 6273. Quantum Computing** A comprehensive overview of quantum computing ecosystem, covering quantum mechanics, circuits, architecture, information, algorithms, languages, programming, cryptography, hardware and killer applications. Prerequisites, CS 3113 or “B” or better in CS 5032, and CS 3223.

**CS 6313. Data Security** Methods for protection, security, and privacy of data; access controls, authentication, cryptographic controls, information flow controls, security kernels. Security of data in networks. Prerequisite, CS 3233 or “B” or better in CS 5032.