

**University of South Carolina**  
**Department of Computer Science and Engineering**  
**CSCE 790:008 Quantum Programming Languages**  
**Spring 2024**

<b>Instructor</b>	Peng (Frank) Fu
<b>Email</b>	pfu@cse.sc.edu
<b>Meeting Times</b>	Tuesday and Thursday (1:15-2:30pm)
<b>Meeting Location</b>	Swearingen Engr Ctr, Room 2A22
<b>Office Location</b>	Innovation Center (INNOVA) 2229
<b>Office Hours</b>	Tuesday and Thursday (12pm-1pm)

## Course Description

This course introduces background and research topics in quantum programming languages. The topics include both theoretical foundations of quantum programming languages and the practical aspects such as design and implementation of quantum programming languages.

## Academic Bulletin Description

CSCE 790:008 Quantum Programming Languages (3 Credits)

Foundations of quantum programming languages; no-cloning property; syntax and semantics of linear type system; categorical semantics of quantum programming languages; quantum lambda calculus; quantum circuit description languages; programming quantum circuits.

## Prerequisites

There is no prerequisites for this course.

## Course Learning Outcomes

Students will be able to:

- Explain various semantics models of quantum programming languages.
- Demonstrate basic knowledge on the implementations of quantum programming languages.
- Write simple programs in a quantum circuit description language.
- Read, present and criticize papers on various topics of quantum programming languages.

## Textbooks

There is no required textbooks. There will be a reading list and lecture notes.

## Grades calculation

- 20% Class participation. Students are required to attend each class and participate in the Q/A phase of the presentation. Absence from more than 10 percent of the scheduled class sessions, whether excused or unexcused, is excessive, and the instructor may choose to deduct the class participation points for such absences. It is of particular importance that a student who anticipates absences in excess of 10 percent of the scheduled class sessions receives prior approval from the instructor.
- 20% Homework assignments.
- 40% Course project. There will be one semester-long project. The details of the project will be posted on course's website.
- 20% Paper presentation. Each student will choose one research paper in consultation with the instructor and present it to the class. This will be a timed presentation with Q/A from the audience, and the presenters will be evaluated based on the preparation of slides, clarity, and coverage of the topics discussed.

The grading scale is,  $90 \leq A \leq 100$ ,  $85 \leq B+ < 90$ ,  $80 \leq B < 85$ ,  $75 \leq C+ < 80$ ,  $70 \leq C < 75$ ,  $65 \leq D+ < 70$ ,  $60 \leq D < 65$ ,  $F < 60$ .

## Assignment and Assessment Policy

All the homework assignments have to be done individually. Project reports and codes must be submitted through Blackboard or Departmental dropbox. Grade appeals for any assessment must be requested (via email to me) within three days of my posting of the grade. While I will always answer your questions on the grading of an assessment, your score on the assignment will not be changed unless you request a grade review during the 3-day grade appeal time period.

## Late Homework Policy

Late homework is accepted with a 10% penalty until the beginning of the class after the due date.

## Tentative Course Plan

WEEK	TOPIC
1	Introduction to quantum circuits (1)
2	Introduction to quantum circuits (2)
3	Programming language foundations
4	Syntax and semantics of an idealized quantum circuit programming language
5	Modern quantum programming languages (1)
6	Modern quantum programming languages (2)
7	Modern quantum programming languages (3)
8	Equational theory of quantum circuits
9	Formal verification of quantum circuits
10	Categorical quantum mechanics
11	Graphical language for quantum computing (1)
12	Graphical language for quantum computing (2)
13	Paper presentation
14	Measurement based quantum computing
15	Stabiliser formalism
16	Optional topic
	Final project report

## Academic Integrity

As a partner in your learning, it is important to both of us that any assignment submission is a pure reflection of your work and understanding. The introduction of artificial intelligence options to complete academic work jeopardizes my ability to evaluate your understanding of our course content and robs you of the ability to master the subject matter.

Suspicious of use of artificial intelligence aids will be referred to the Office of Academic Integrity as alleged violations of Cheating, defined as “unauthorized assistance in connection with any academic work” and/or Falsification, which includes “Misrepresenting or misleading others with respect to academic work or misrepresenting facts for an academic advantage”. You are expected to practice the highest possible standards of academic integrity. Any deviation from this expectation will result in a minimum academic penalty of your failing the assignment, and will result in additional disciplinary measures. This includes improper citation of sources, using another student’s work, and any other form of academic misrepresentation. The first tenet of the Carolinian Creed is, “I will practice personal and academic integrity.” Below are some websites for you to visit to learn more about University policies:

- Carolinian Creed (<http://www.sa.sc.edu/creed>)
- Academic Responsibility (<http://www.sc.edu/policies/staf625.pdf>)
- Office of Student Conduct and Academic Integrity (<https://www.sa.sc.edu/academicintegrity/>)
- Information Security Policy and Standards ([https://sc.edu/about/offices\\_and\\_divisions/division\\_of\\_information\\_technology/security/policy/universitypolicy/](https://sc.edu/about/offices_and_divisions/division_of_information_technology/security/policy/universitypolicy/))

## Disability Services

Student Disability Resource Center (<http://www.sa.sc.edu/sds/>): The Student Disability Resource Center (SDRC) empowers students to manage challenges and limitations imposed by disabilities. Students with disabilities are encouraged to contact me to discuss the logistics of any accommodations needed to fulfill course requirements (within the first week of the semester). In order to receive reasonable accommodations

from me, you must be registered with the Student Disability Resource Center (1705 College Street, Close-Hipp Suite 102, Columbia, SC 29208, 803-777-6142). Any student with a documented disability should contact the SDRC to make arrangements for appropriate accommodations.

## Mental Health

If stress is impacting you or getting in the way of your ability to do your schoolwork, maintain relationships, eat, sleep, or enjoy yourself, please reach out to any of our mental health resources. Most of these services are offered at no cost as they are covered by the Student Health Services tuition fee. For all available mental health resources, check out Student Health Services Mental Health ([https://www.sc.edu/about/offices\\_and\\_divisions/health\\_services/mental-health/index.php](https://www.sc.edu/about/offices_and_divisions/health_services/mental-health/index.php)) and the quick reference list below.

- Wellness Coaching can help you improve in areas related to emotional and physical wellbeing (e.g., sleep, resiliency, balanced eating and more) – schedule an appointment at (803) 777-6518 or on MyHealthSpace ([https://myhealthspace.ushs.sc.edu/login\\_dualauthentication.aspx](https://myhealthspace.ushs.sc.edu/login_dualauthentication.aspx))
- Access virtual self-help modules via Therapy Assistance Online (TAO) (<https://us.taoconnect.org/register>) – see TAO registration instructions ([https://www.sc.edu/about/offices\\_and\\_divisions/health\\_services/medical-services/counseling-and-psychiatry/online-support/index.php](https://www.sc.edu/about/offices_and_divisions/health_services/medical-services/counseling-and-psychiatry/online-support/index.php)).
- Access additional articles and videos on health and wellness topics on the Wellness Hub, thriveat-carolina.com, or by downloading the CampusWell (<https://www.campuswell.com/>) app and searching for University of South Carolina.
- Counseling & Psychiatry offers individual and group counseling and psychiatric services – schedule an appointment at (803) 777-5223 or on MyHealthSpace ([https://myhealthspace.ushs.sc.edu/login\\_dualauthentication.aspx](https://myhealthspace.ushs.sc.edu/login_dualauthentication.aspx)).
- Access the 24-hr Mental Health Support Line at (833) 664-2854.
- Access an anonymous mental health screening program (<https://www.uscscreening.org/welcome.cfm?access=website>)