Gifted Education Fund: Off-school Advanced Learning Programmes

Programme No. 2022-07 (For secondary students)

Title of Programme	**Quantum Computing for Gifted Students**
Programme Provider	Department of Physics, The Hong Kong University of Science and Technology (Supporting organisation: The Hong Kong Academy for Gifted Education)
Theme	STEAM-related Mentorship Programme
Maximum No. of Participants and Class Level in the 2022/23 School Year	40 students (Secondary 4-5)
Pre-requisite	• Applicants should show interest in physics and computing, demonstrate outstanding performance in mathematics. • Applicants should study HKDSE Physics or equivalent. • Applications should study (i) HKDSE Mathematics Compulsory Part and Extended Part Module 1 (Calculus and Statistics), or (ii) HKDSE Mathematics Compulsory Part and Extended Part Module 2 (Algebra and Calculus); or (iii) equivalent curriculum.
Programme Delivery Period	From July 2023 to January 2024 (7 months) (tentative)
Medium of Instruction	Course Material: English Class teaching/ Discussion: English supplemented with Cantonese/ Putonghua
Objectives	• To equip the gifted students with the knowledge of the scientific principles on quantum computing and quantum information processing; • To familiarise the students with the applications of quantum computing in different fields; • To provide hands-on learning opportunities for students to apply quantum algorithms on small-scale computation projects; • To increase the students' awareness of the current development of quantum computing in China and the interesting connection between quantum physics and the world of art; and • To nurture positive values and attitudes such as perseverance, ethical use of quantum computing for the well-being of mankind, willing to collaborate with others, etc. and promote the affective development of the gifted students.

Programme Outline	This programme enables gifted students to understand the operation of quantum computers, the algorithms that are used in quantum computing and also the available applications. Students will acquire useful skills in writing and testing programmes on desktop quantum computers for education and research. They can also learn and appreciate the current development of quantum computing in China and the connection between quantum physics and art. Besides, through the learning and teaching activities, students can develop positive values and attitudes essential for personal growth and development. An educational psychologist will be deployed to conduct a lesson on affective education for the student participants.

The programme consists of three phases.

Phase 1: Fundamentals of quantum computing (36 hours in total)
- Mode: lessons
- Students will acquire essential mathematics knowledge (matrix algebra and complex numbers) for understanding the language of quantum computing, architecture of quantum computers, quantum states and qubits, multiple qubits and entanglement, means of building a quantum computer, quantum circuits, quantum algorithms, etc.
- A session will be conducted by an educational psychologist to promote affective education among the students so that they may better face challenges or difficulties encountered. Another session is reserved for introduction of the current development of quantum computing in China.

Phase 2: Programming quantum algorithms (22 hours in total)
- Mode: lessons and tutorials
- Students will learn the principles and mechanisms of quantum algorithms in computing, and also their advantages. During the programming exercises and tutorials, students will apply the quantum algorithms learnt and complete hands-on exercises using quantum protocols with an online quantum programming toolbox.
- A session will be arranged at the end of this phase to show the connection between quantum physics and the world of art inclusive of musical notes and graphics.

Phase 3: Small-scale projects and showcase event (about 12 hours for each group)
- Students will be divided into groups of 4, who will work on a small-scale project on quantum computing. An instructor will be assigned to each group as a mentor who will meet and supervise the students.

	• Students will collaborate and conduct literature search of a particular algorithm, try to understand the design of relevant quantum circuits and start coding the algorithm on quantum computer simulators and/ or using other quantum computer resources online. They will report their work progress and seek advices from the instructors/ mentors during the meetings. • A showcase event/ closing ceremony will be arranged by the end of the programme for each group of students to present their projects and results. Parents, teachers and other guests will be invited to attend the event.
Admission Fee	Free of charge
Application Method	Application form can be downloaded from the following webpage: https://www.edb.gov.hk/en/curriculum-development /curriculum-area/gifted/ge_fund/gef/programme/current.html Please complete the application form and send it by post <u>on or before 21 April 2023</u> to the following address: Department of Physics The Hong Kong University of Science and Technology Clear Water Bay, Kowloon (Attn: Prof LI Jensen Tsan Hang)
Documents to be Submitted along with the Application	• Please write about the following in the section of Student's Self-introduction in the application form (in 500 words): - reasons for applying for this programme; - subjects that the student is currently taking; and - physics, computer knowledge and skills
Enquiry	Mr YU Chiu-kwan (Department of Physics, The Hong Kong University of Science and Technology) Tel No.: 3469 2431 Email: yuck@ust.hk
Date of Announcement of Result	By 31st May 2023 (tentative)