**Geometry and Education**
**Course Outline** (updated)
**Course 7412062 Section 01, Fall 2024**
**Thursdays 14:00 - 16:50, Room: E1-1 #136**
**Chungbuk National University**

*This document prevails whenever interpretations of the course syllabus (the version in 개신누리) and that of this document conflict. This document contains terms and conditions on how this class will be administered throughout the semester. Registering for this class means you agree on plans, policies, and details in this document. You MUST drop this course if you disagree with any item listed in this document.*

**Instructor:** Dr. Byungdo Park

**Email:** `byungdo@chungbuk.ac.kr`

**Office hours:** Wednesdays 15:00–15:50 at E1-1 #110 or by appointment.

**Class webpage:** Announcements, homework, exam schedules and other relevant information will be posted on the following webpage: `https://byungdo.github.io/teaching/f2024_ge.html` which is also accessible via instructor's webpage: `https://byungdo.github.io/`

**Textbook:**

- R. Shankar, *Principles of Quantum Mechanics*, 1st Edition (1994), Springer New York NY, ISBN-13: 9780306447907.

**References:**

- P. A. M. Dirac, *Principles of Quantum Mechanics*, 4th Edition (1988), Oxford University Press, ISBN-13: 9780198520115

**Prerequisites:** Calculus, linear algebra, and differential equations. The instructor does not dissuade students without meeting the prerequisite criteria registering for this course at his/her own risk.

**Course description:** This subject serves as an advanced topics course in geometry and geometry education. More specifically, this subject aims to provide students with a panoramic view of these areas. In this semester, we will focus on the interaction between geometry and physics, with a particular emphasis on quantum physics. This course introduces mathematics education majors to the geometric foundations of modern physics. It is designed to help students understand the interplay between mathematics and physics, and develop the ability to utilize this knowledge in their future teaching careers.

**Course objectives:** At the end of the course students should be able to:

- Understand and interpret the fundamental concepts and principles of quantum mechanics from a geometric perspective. (Convergent Major Competency)
- Master the mathematical foundations of quantum mechanics, including Hilbert spaces, bra-ket notation, and wave functions. (Convergent Major Competency)
- Analyze key quantum mechanical phenomena such as the Schroedinger equation, the uncertainty principle, and quantum tunneling using geometric approaches. (Convergent Major Competency)
- Explore the connections between quantum mechanics and geometry, gaining insight into the interactions between these two fields. (Convergent Major Competency)
- Develop the ability to explain the geometric foundations of modern physics in the context of secondary mathematics education. (Comprehensive Thinking and Creative Problem-Solving Competency)
- Cultivate skills in visualizing and modeling quantum mechanical concepts, and learn to use these as educational tools. (Self-Management Competency)
- Recognize the importance of STEM education based on an integrated understanding of mathematics and physics, and explore ways to apply this in future educational settings. (Global Competency)
- Understand the historical development of quantum mechanics in the context of the history of science, grasping the historical connections between mathematics and physics. (Global Competency)
- Apply geometric thinking to solve problems in quantum mechanics and articulate the solutions in ways accessible to secondary school students. (Comprehensive Thinking and Creative Problem-Solving Competency)
- Critically evaluate the role of geometry in the formulation and interpretation of quantum theory, fostering a deeper appreciation for the interdisciplinary nature of scientific inquiry. (Self-Management Competency)

**Details on class proceeding:** This course adopts a Problem-Based Learning (PBL) approach, emphasizing active student participation and collaborative learning. Students are expected to thoroughly prepare by reading the main textbook before class, enabling them to explain concepts to peers. During sessions, the instructor moderates while students lead discussions, presenting their understanding in a logical manner. This method enhances deep comprehension of quantum mechanics and geometry, develops critical thinking and communication skills crucial for future educators, and fosters the ability to make interdisciplinary connections. By engaging in this student-centered approach, participants not only gain a solid grasp of complex topics but also cultivate essential teaching competencies, preparing them for the challenges of modern mathematics education.

**Grading policies:** 90% from class participation, 2% from final exam, and 8% from attendance. Absolute evaluation [A: 100–90 points, B: 89.99–80 points, C: less than 80 points] with curving.

Here the curving means a horizontal shift of the bell-shaped curve of %-score distribution in either directions using a rational constant which is determined at the discretion of the instructor. Grading policies in the attendance policies, academic integrity policies, and classroom attitude policies are applied in higher priority (in this order) than the above grading policies. Those who are in their final semester and have to show up to work during the semester, special rules apply in accordance with the university policies (cf. 충북대학교 학칙 제34조의2, 학사운영규정 제86조의3).

**Homework policies:** Homework problems might be assigned but they will not be a part of the assessment for this course.

**Classroom attitude policies:** The instructor may apply up to 5 points per day (up to 10 points per day for repeated cases) of deduction of your total score against any of your attitude which the instructor views it inappropriate. The sum of total score deduction due to these policies may not exceed 20 points throughout the semester. Inappropriate attitudes are (i) anything you do in the classroom that disturbs and/or distracts the instructor or other students or (ii) disturbing and/or distracting the instructor from administering this class. If you violate, you will be notified via email registered in 개신누리 and it gets confirmed if you do not dispute in a written form in 7 days.

**Attendance policies:** (1) Attendance data will be collected in every class meeting and will be used for determining your final grade. You will get a grade F if you have missed more than 25% of class meeting hours. Up to 3 hour of absence there is no penalty on your score. After that, you lose 1% of total score for an absence to each 50-minute long class meeting, with a maximum total loss 8% from your total score.

(2) If you have permissible reasons for your absence in accordance with the Regulation on Academic Management of the CBNU Article 52(1) (충북대학교 학사운영규정 제52조(공결승인) 제1항), you will need to contact your department secretary to follow the procedure for getting an approval on your absence bringing proper documentation as proof. That said, you have to fill out a form and submit it along with appropriate proofs before the absence or after seven days of the date of absence.

(3) If you responded to an attendance call and leave the classroom (even if you come back later) while the lecture is still going on, you will be considered to be absent for that attendance call *if you report later to the instructor that you left during the class within that day's class.* If you don't report and your arbitrary and sudden leave gets caught, you will be considered to be absent for that day's class and it will be treated as a violation of classroom attitude policies.

(4) Any dispute about in-class attendance records must be made before the instructor physically leaves the classroom after that day's class meeting.

**Makeup exam policies:** If you could not take any exam and would like to take a makeup exam to the missing exam, you must follow the following guideline:
`https://byungdo.github.io/teaching/makeup.pdf`

**Program Learning Outcomes Assessment:** This course contributes to the following major

competencies and learning outcome indicators:

1. Convergent Major Competency
   - Indicator 1-1 (Convergent Course Completion Rate):
   * The entire course is structured around the integration of geometry and quantum physics
   * Assessment: Course completion itself contributes to convergent course credits
   - Indicator 1-2 (Mathematical Software Utilization):
   * Visualization and modeling of quantum mechanical phenomena using geometric software tools
   * Assessment: Evaluation through students' presentations and discussions using visualization tools

2. Comprehensive Thinking and Creative Problem-Solving Competency
   - Indicator 2-2 (Teaching Plan Assessment):
   * Development of teaching plans that transform quantum-geometric concepts into secondary mathematics contexts
   * Assessment: Evaluation of students' ability to articulate complex concepts at an appropriate level through their PBL presentations

3. Self-Management Competency
   - Indicator 3-1 (Participation in Extracurricular Programs):
   * Active participation in PBL discussions and presentations
   * Assessment: Quality of participation and contributions to class discussions (90% of total grade)
   - Indicator 3-2 (Study Group Activities): * Collaborative learning through peer discussions and group preparation
   * Assessment: Observed engagement in collaborative learning activities

4. Global Competency
   - Indicator 4-1 (English-Medium Course Completion):
   * Use of English textbook and terminology
   * Assessment: Understanding of technical terms and concepts in English through class participation
   - Indicator 4-2 (Global Program Participation):
   * Understanding of international STEM education trends
   * Assessment: Integration of global STEM perspectives in PBL presentations

The assessment results for each indicator will be primarily evaluated through the students' participation in PBL discussions (90%), final exam (2%), and attendance (8%), reflecting their ability to integrate geometric and quantum mechanical concepts while developing educational perspectives. The results will be submitted to the Department Performance Management Committee, and reflected in the course CQI report.

**Important dates:**

- Thursday October 3rd – National Foundation Day. Make-up date: TBA

**Weekly lesson plan:**

Week 1: Mathematical introduction

Week 2: Mathematical introduction

Week 3: Review of quantum mechanics

Week 4: Review of quantum mechanics

Week 5: All Is Not Well with Classical Mechanics

Week 6: The Postulates—a General Discussion

Week 7: The Postulates—a General Discussion

Week 8: The Postulates—a General Discussion

Week 9: Simple Problems in One Dimension

Week 10: Simple Problems in One Dimension

Week 11: The Classical Limit

Week 12: The Harmonic Oscillator

Week 13: The Harmonic Oscillator

Week 14: The Harmonic Oscillator

Week 15: The Heisenberg Uncertainty Relations. 50-minute final exam.

**Classroom for a small-size class:** We may meet at the instructor's office E1-1 Room 110 if the class size is 3 or less.

**No video lectures provided for students' absence in any causes:** The instructor may have to change the course's plan and give some of lecture via online in accordance with the 충북대학교 원격수업운영지침 제15조(결강 및 보강)제2항. However, the instructor will not provide recorded video of any part of class meetings even if one or more students' cause has an official cause listed in 충북대학교 학사운영규정 제52조(공결승인)제1항.

**Dispute policies:** (1) The instructor will announce a date and an interval of time for you to see (and dispute if you wish) your graded papers. For that you have to respond and set up an appointment by email until the specified deadline. If you respond, the instructor will give you a specified date, time, and location for you to show up. There will be an option to give up your rights to dispute and just get notified your scores by email.

(2) If the specified date and an inverval of time in the announcement conflicts with your other classes or other equivalently official schedules, you may request a rescheduling by attaching your time table or a relevant document showing that you have other official matters.

(3) If you do not respond by the deadline in each announcement, the instructor will have to assume that you give up your right to dispute and the grading is flawless. For example, if you inquire after your letter grade is assigned, the instructor will only look into whether there is any error in entering your final grade and will dismiss all inqueries on the raw data.

**Accommodating disabilities in learning and assessment:** The instructor is committed to providing access to all students. If you need accommodation in classroom or in assessment, you are encouraged to set up an appointment with the instructor at your soonest availability so that we can figure out the best way to acoommodate you. Possible accommodations include, but not limited to, provision of materials from lectures, permission to hire an assistant for taking notes, audio-recording lectures, and aid/assistant devices, extension of due dates for assignments, alternative assessment for in-class presentations, extension of exam hours, and provision of an accommodating exam locations and exam sheets.

**Academic integrity:** It is expected that you will complete all exams without giving or receiving help from anyone. Electronic devices are not allowed in any in-class exam. If you violate any of these policies, you receive score zero to that exam at the discretion of the instructor. In addition, your case will be handled through the standard procedure of the university. Note that a use of your smartphone during an exam is simply a cheating.

**Email policies:** All emails addressed to the instructor should have a title containing the course title, name, and a brief summary as well as a body starting with "Dear Professor Last name" and ending with "Sincerely, Your full name", which contains greetings, your name and department, a brief and clear purpose written politely. Any email deviating from this format will not be accepted and will be dismissed without any rejection reply. The corresponding disadvantages are solely and entirely on the student.

**이메일 작성규칙:** 담당교수에게 보내지는 모든 이메일의 제목에는 과목명, 신원, 요지가 포함되어 있어야 하며, 본문은 반드시 "OOO 교수님께"로 시작하여 인사, 신원, 용건을 간단 명료하고 예의 바르게 기술한 후 "OOO 올림" 또는 "OOO 드림"으로 끝나야 합니다. 이 형식에 어긋난 이메일은 접수하지 않으며, 반려회신 없이 종결합니다. 이에 따른 불이익은 전적으로 학생의 단독 책임입니다.

**English usage policies:** Lectures in this course will be given in Korean, but most of written materials will be in English. For example, the course syllabus, most of boardwork, exam problems, homework, solutions to exams, course webpage, announcements, but not limited to those. English sentences to be used in this course should be understandable enough based on the regular Korean public high school curriculum. Nonetheless if your English skill is not competent enough to follow this course or understanding announcements, it is your responsibility to ask the instructor to also provide an explanation in Korean. The instructor will take those questions under an attitude of helping students' understanding, but taking into account the contents of each question, he may

reject the question or advise the questioner to visit him during his office hour to ask the question about Korean translation.

**영어 사용 정책:** 본 강좌에서 강의는 한국어로 이루어집니다만, 글의 경우 대부분 영어가 사용될 것입니다. 수업계획서, 칠판 판서의 대부분, 시험문제, 숙제, 시험문제에 대한 풀이, 강좌의 웹페이지, 공지사항 등이 예가 될 수 있으며, 이상 열거한 것들로 한정되지 않습니다. 본 강좌에서 사용될 영어 문장들은 한국의 공립 고등학교 정규 교과과정을 기초로 할 때 충분히 이해될 수 있어야 합니다만, 만약 수강생 본인의 영어실력이 본 강좌를 따라오거나 공지사항을 이해하기에 충분치 못하다면, 담당 교수에게 한국어로 추가 설명을 요청하는 것은 학생 본인의 몫입니다. 담당 교수는 학생들의 이해를 도우려는 자세로 질문을 받을 것이지만, 질문의 내용에 따라 답을 하지 아니할 수도 있고, 면담시간에 개별 방문하여 질문하도록 안내할 수도 있습니다.