INSTRUCTION: Using the following format, prepare a Teaching portfolio for any one of the courses taught. A core course with a large number of students is preferred. Retain the **blue** coloured headings as it is and enter your details in **black** coloured texts.

Teaching Portfolio

Name: Dr. Shyamal Chatterjee, Dept: Physics, SBS, Email: shyamal@iitbbs.ac.in

1) Course Details:

Name: Quantum Physics I, **Code:** PH2L302 (L-T-P: 3-0-0) **Semester:** Spring- 2024

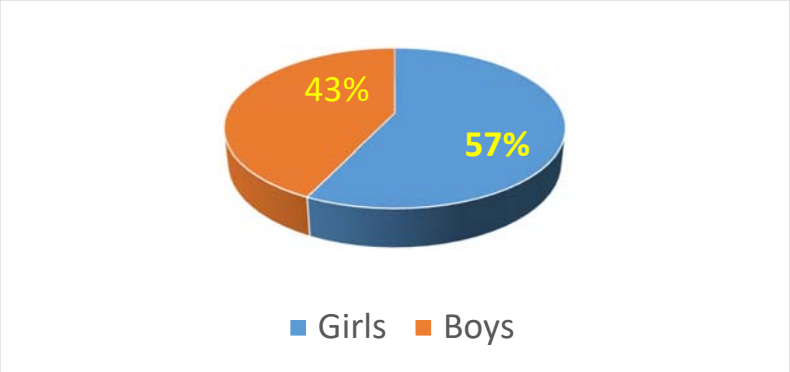
One Text / Reference Book:

a) Concepts of Modern Physics, (McGraw-Hill): by Arthur Beiser (Text Book)
b) Introduction to Quantum Mechanics (Cambridge University Press): by David J Griffiths and Darrellf Schroeter (Refence Book)

Course Content (only key topics):

Experimental evidence of failure of classical physics and introduction to quantum mechanics, Bohr model of atomic hydrogen, Correspondence principle. Wave properties of matter, de-Broglie wavelength, Experiments demonstrating wave properties of electron: Electron interference, Concept of Wave packets, Interpretation of the wavefunction, probability, the Schrödinger equation, Expectation value, Uncertainty principle. Solution of Schrödinger equation using various one-dimensional potentials.

Class composition: 14 students



2) Learning outcomes (mention up to 5 points):

After completing the course, it is intended that students will be able to:

- Explain the limitations of classical physics and the necessity of quantum mechanics.
- Interpret the experimental evidence for quantum phenomena, such as the photoelectric effect, blackbody radiation, and the Compton effect.
- Explain the probabilistic nature of quantum mechanics and its departure from deterministic classical physics, behaviour of wavefunction and its interpretation.
- Figure out how to normalize a wavefunction and how to find out expectation values.
- Solve Schoedinger equation for given potential such as particle in a finite and infinite potential well, particle crossing a potential of larger energy than the particle energy, a step potential etc.

3) Assessment format:

Seminar (10 marks); Assignments and class response (10 marks), Two class tests (10 marks) – Open notes; Mid-sem (30 marks) – Closed book; End-sem (40 marks) – Closed book.

4) Attendance policy:

Latecomers were marked and warned for penalties, if continues the same. The attendance was monitored and a couple of students were informed over email when they were absent by more than 2-3 classes. The faculty advisor was also informed about the students who were absent for a week continuously.

5) Teaching-aids: Describe briefly usage of chalkboard, projection, multi-media, anything else

Classes were taught mostly using chalkboards. In some occasions power point presentations were used for visualization of images, animation and videos. There were a few activity-based classes where lasers, gratings, paper cuttings, plastic balls meter sticks were used for demonstrations. For instance, I have demonstrated how quantum mechanical perspective can be obtained in case of single slit diffraction of laser light.

6) Activities and fraction of class time spent on these (Reference - bookend lecture model):

Details of classes conducted in Active Collaborative Learning (ACL) Classrooms

Room No	Date	Duration		Nature of activities
		From	To	
L03S	26/09/2024	10 AM	12 Noon	There was no separate tutorial class for this course. I divided the class in two groups (7 students in each group) and asked each group to frame a couple of conceptual numerical questions. The questions were solved by the other groups by discussing among their own members. This helped to study together in group and solve problems together.
L03S	26/09/2024	4 PM	5 PM	Gave activities to students divided into groups to figure out equivalent parameters of Bohr model in visible range of real world.

7) Details of activities in other classes

Lecture Class: At the end of each class I used to ask students the key take away of each class, which was a kind of brief revision of the entire class. I also used to ask the topics that were unclear and I used to take up those topics again in the next class. I asked each of the students to choose an interesting topic from quantum mechanics and explain on board assuming 12^{th} standard students are the audience. This sharpened their teaching skill and at the same time topics outside of the syllabus were also become known to the students. Someday I gave two models namely Schoedinger and Bohr model in two groups and asked the groups to come up with points that which model is most successful.

Tutorial Class: There was no separate tutorial class for this course. Sometimes, I divided the class in two groups (7 students in each group) and asked each group to frame a couple of conceptual numerical questions. The questions were solved by the other groups by discussing among their own members. This helped to study together in group and solve problems together.

8) Concepts / principles taught with either analogies or multiple points of view:

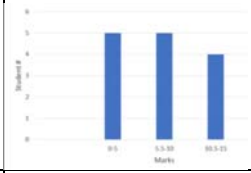
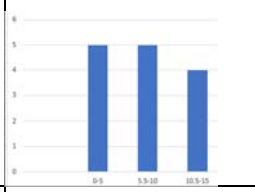
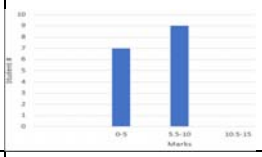
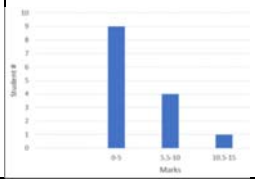
Quantum mechanics is full of counterintuitive concepts, so using analogies and multiple perspectives can be effective. For example, in Quantum Tunneling, A ball rolling over a hill classically needs enough energy, but in quantum mechanics, it can "tunnel" through the hill like a ghost. Another classical analogy is frustrated total internal reflection and nice videos are available online to demonstrate that. Another practical view is how current conducts in the wires which just twisted and not joined.

9) **Up to 5 most significant questions asked by students (give Roll no. and name):**

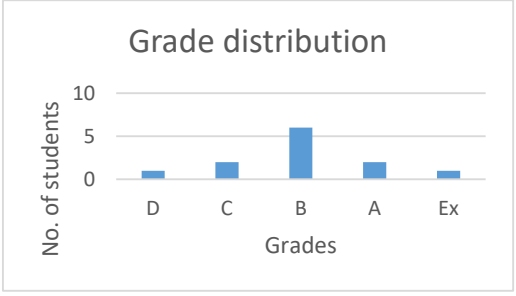
Include questions which made you think, and you could not answer immediately.

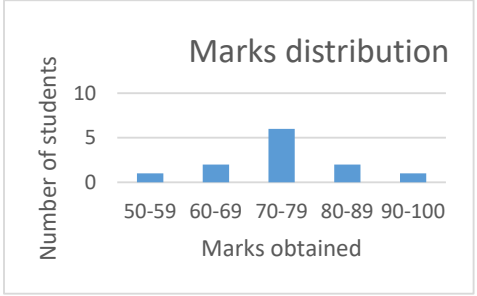
Question	Student name & Roll no
What do our eyes detect, wave nature or particle nature of light?	Himanshu Bhushan Dubey, 23PH03001
Is electron a discrete particle or a cloud like distribution in atoms?	Shakti Sagar Das, 23PH03008
How to divide classical and quantum regimes?	Sambhabana Srichandan, 23PH03016
Can we observe any manifestation of quantum mechanics in daily life?	Krishna Kumari Badatya, 23PH03009
What is quantum entanglement?	Suhani Jakhar, 23MA03005

10) Up to 5 critical thinking level questions from assignments and examinations together with the marks, answering time and student performance:

Question	Time & Marks	Performance
Examination questions		
A beam of mono-energetic neutrons corresponding to a temperature 300K allowed to fall on a crystal. A first order reflection is observed at a glancing angle 300. Calculate the lattice spacing of the crystal planes.	15 min 10 marks	
Calculate the number of electrons, with energy 1eV, that will transmit per sec through a one-dimensional rectangular potential barrier of height 5 eV and width 1 A^0, if 10000 electrons are incident on the barrier per sec.	20 min 15 marks	
Find out the expression of the de Broglie wavelength of a particle of charge *e*, rest mass m_0 moving at relativistic speed is given a function of potential *V*.	15 min 10 marks	
Assignment question		
Is it possible to normalize free particle wavefunction? Explain. If the answer is no, then how one can do this?	30 min 10 marks	

11) Overall student performance and grading policy:



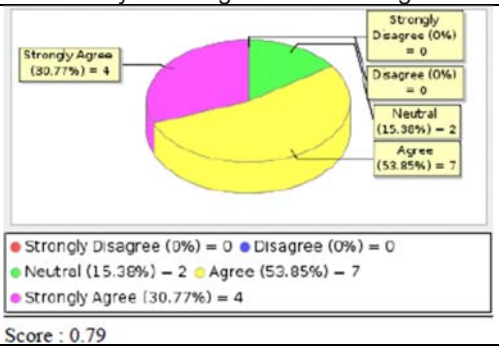
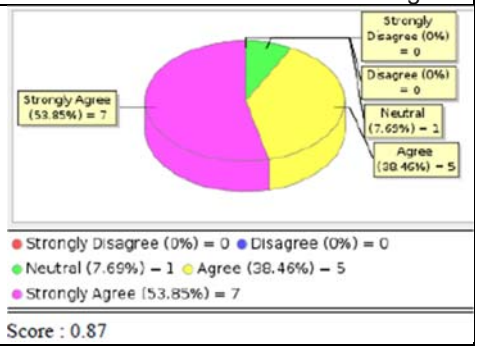


12) Feedback provided to the students on their performance in the assignments, examinations and activities:

All assignment problems were discussed in the class after the due date of submission and common mistakes made by the students are also discussed. I gave more similar types of problems to the students who solved the initial problem wrongly. This cleared their doubts. Both mid-semester and end-semester exam papers were shown to the students and their queries/doubts were resolved. Problems given in the midsemester were also discussed in the class after the exam.

13) Students' feedback:

Perception at the end of the course:

Statement	The faculty handling the course taught well.	The course contents were exciting.
Response	 Score : 0.79	 Score : 0.87

14) Descriptive comments at the end of the course (mention up to 5 most significant comments):

Aspects of the course and the teacher that need improvement:

1. May be should have more out of the course thinking assignment
2. There can be more tutorial classes for better understanding of topics.
3. There should be more problem-solving classes.
4. Evolution and scope of the course should be taught may be in first two lectures to make course more interesting.
5. Some of the demonstrations can be shown outside of the Learning Hall complex for enhanced experience (From Peer Colleague)

What did I like most about the course and the teacher?

1. We learnt many new things. We learnt about the amazements that quantum mechanics carry on it. The teacher was focused. He was systematic and organized throughout the course. He tried to explain practically. Sometimes he used to bring setup from labs to make us understand the concept.

2. Professor taught each and every topic of QUANTUM PHYSICS in a interesting way. He used to explain in his unique way of teaching. The presentation during the course helped us to know more about the world of quantum physics.

3. Relating the lessons to the history of science and explaining as intuitively as possible.

4. The course content was well-organized, provided in-depth knowledge and understanding of quantum mechanics and the Teacher explained each concept well, making the complex concepts easy to understand by live demonstration and using real-life examples.

5. sir taught in a very systematic and understanding manner.

15) Identifying and dealing with students who are either gifted or need special attention because of low performance or psychological problems:
Mention if you identified a student who needed professional counselling.

Student name	Roll no	Manner of identification	Nature of attention provided
Kaza Vaidya Naga Prasad	23PH03005	He was unable to do well in the tests and class interactions and assignments.	Called several times in my office beyond the class to explain the topics covered and how to solve the problems. Asked his friends to help the concepts so that he feels free to discuss.
Kumarsri Gourab Kar	23PH03007	He was absent from the classes since beginning of the semester and he used to give bizarre excuses for that.	I have tried to convince him in several occasions without any success. I have informed his case to concerned faculty advisor, who talked to the student and his parents and finally he was sent to the counsellor to sort out any issue with him.

16) Peer feedback on teaching

Dr. Shyamal Chatterjee <shyamal@iitbbs.ac.in>

Feedback for the course Quantum Physics I

R Venkata Raghavan <raghavan@iitbbs.ac.in> Thu, Jan 2, 2025 at 1:26 PM
To: "Dr. Shyamal Chatterjee" <shyamal@iitbbs.ac.in>

Hello Sir,

Please find below my feedback for the course. Thank you again for allowing me to attend the course.
Regards
Raghavan
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I attended the course Quantum Physics-I taught by Dr. Shyamal Chatterjee out of personal interest in the subject. I was able to attend majority of the classes and found the course thoroughly enjoyable. What I liked about the course content was that it gave a relatively close understanding of the key discoveries in the early phases of Quantum Physics (QP) without being too heavy on the students. Dr. Shyamal was punctual and regular to class and taught very well. He included historical details as part of his lecture which I found very enriching. I am sure he will add more such details in future since they help a student of Physics understand how the discipline itself was shaped in those first 30 years of the 20th century. A few photographs of the experimental setup may be shown apart from the diagram on the board. Dr. Shyamal also gave an experiential demonstration of the distance between the nucleus and the electron which was fun. I strongly recommend that he does this outside the learning hall next time to enhance the experience. At the end of each class, he would ask the student what was their key takeaway from that class. This is a very nice way of helping the student revise the entire class and reinforcing one or two topics taught in it.
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