PH 107 (2021)
Quantum Physics and Applications

Instructors:

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Why learn Quantum mechanics?

- Quantum mechanics is considered the most important discovery of the 20th century.
- Quantum theory made it possible to understand atoms. Atoms make molecules and there by understand Chemistry --- the chemical bond. Chemistry is the basis of Biology.
- Quantum mechanics permits us to understand solid bodies and there by conduction of electricity in solids.
- Quantum theory is the basis of semi-conductors. Semiconductor devices made possible miniaturized electronics, including the laptop/tab/mobile phone you are seeing this slide with!
- Many technological inventions of the last 60 years are based on principles of quantum mechanics.

Quantum theory in the real world

Practical Applications

- LASERs
- Semiconductors
- Transistors
- LED
- Night Vision Goggles
- CCD
- MRI / PET

Explanation of Phenomena

- Tunnelling
- Radioactive decay
- Periodic table
- Anti-matter

(Pauli Exclusion Principle explanation to Mendeleev's chart)

Quantum theory in the future

- Dot LASERs
- Logic gates
- Computing
- Cryptography / Encryption
- Cloning
- Teleportation

PH-107: Learning objectives

- Some insights paved way to our understanding of microscopic systems.
  - evidence of the wave nature of electrons and describe how their wavelength depends on speed
  - explain how quantum theory differs from classical physics
- solve simple physical problems to understand
  - Quantization of energy
  - Tunneling of particles
- Extend the ideas to Avogadro number of particles
  - Statistical mechanics
  - Applications to solid state physics to exploit new technologies.

PH-107: About the course

- This is a 6 Credits course.
  - 3 contact hours (Teaching + Tutorials)
  - Students need to spend at least 3 more hours to understand the subject
- 2 Lecture hours per week and 1 hour of tutorials where tutors will solve some assignment problems.
- On Friday evening we will upload PDF and video of the lectures of the following week.
  - Students are expected to go through the two videos completely
  - Take down the notes.
  - There will be questions asked in-between the video which you need to solve and upload on SAFE.
- Live session, like today, Student can pose questions and clarify.

PH 107: Syllabus

Quantum Physics and Applications

Introduction Compton Scattering, de-Broglie hypothesis, Electron interference (double slit experiment) and Electron Diffraction (Davison - Germer experiment)
Concept of Wave packets Phase velocity, group velocity
Mathematical interlude Introduction to Fourier Transforms; Few examples (Step potentials, Gaussian wave packet), leading to concept of Uncertainty relation.
Quantum Physics Heuristic derivation of Schrodinger Equation. Concept of free particle, particle in a box problem. Finite Square well. Bound vs. unbound states. Superposition principle of eigenstates. Concept of collapse of wave function. Scattering problem. Reflection and Transmission coefficients. A few examples. Concept of quantum tunnelling. Few realistic examples of tunnelling, e.g. alpha decay, Scanning Tunnelling Microscope.
Introduction to Statistical Physics Basic intro to classical and quantum particles. Pauli's exclusion principle. Micro-states and macro-states. A few examples. Classical (Maxwell-Boltzmann) and Quantum statistics,[Bose Einstein (BE)and Fermi Dirac (FD)]. Derivation of classical statistics and give hints to derive BE and FD. Planck's distribution.

PH-107: Reference Book

Modern Physics (3rd Edition): R. A. Serway, C. J. Moses, C. A. Moyer, Thomson Learning Inc. 2005

There is not enough time in lectures to cover all the material thoroughly. You will gain a much better understanding of the topics by reading the material outside of class. Ideally you will read the relevant chapter before coming to class.

PH-107: Schedule

Lectures for D1 and D2	Tuesday	2:30 – 3:25 PM
Lectures for D1 and D2	Friday	2:30 – 3:25 PM
Tutorials for D1 and D2	Wednesday	3:00 – 3:55 PM
Lectures for D3 and D4	Tuesday	9:30 – 10:25 AM
Lectures for D3 and D4	Thursday	10:35 – 11:30 AM
Tutorials for D3 and D4	Wednesday	4:00 – 4:55 PM

PH-107: Tutorials

- Each Division has 8 tutorial batches.
- Each division will have have an additional tutorial batch (T9).
  This will be exclusively for HINDI as a medium for tutorials.
- Students will be informed of their Teaching Assistants (TAs) by 1st December.
- Students who want to attend the HINDI tutorials should register, by sending an email to ph107@phy.iitb.ac.in by 3rd December 2021.
- Once a student registers for T9 batch, she/he has to continue in the same tutorial batch for the entire semester

Evaluation Scheme

Your final grade will be determined using the following weights:

Category	Number of Times	Weightage	Best of	Percentage
Quizzes from recorded videos*	20	1	14	14 %
Class Participation*	20	0.25	---	5 %
Tutorials**	10	2	8	16 %
MidSemester	1	---	---	25 %
End-Semester	1	----	---	40 %

* Details will be given by Instructors

** Details will be given by Tutors

Video Quizzes and Class participation evaluation

- To enhance your comprehension of a particular subject to be covered, videos related to the week's lecture will be posted on MS-Teams and Moodle.

- It is mandatory for the students to listen to these video lectures.

- Some questions will be embedded in the video lectures.
- Students have to upload the answers to the questions in the video lectures on SAFE.
  - For Tuesday's lecture the time slot to upload the answer is Monday 8:00 – 11:00 PM (every week).
  - For Thursday/Friday's lecture the time slot to upload the answer is Wednesday 8:00 – 11:00 PM (every week).

Video Quizzes and Class participation evaluation

- During the class, some students will be called to answer some questions from the video.
- Both will be used for a cumulative evaluation at the end of the semester.
- The class participation marks are entirely up to the Instructor and no questions can be asked about it.

Online classes and tutorials : MS Teams

- Classes as well as Tutorials will be conducted on MS Teams platform.
- Recorded video Lectures and Tutorial sheets will be available on MS teams well before the class timings. Recorded lectures and Tutorial sheets will ALSO be available on Moodle.
- During the class hours, there will be ONLY a review of the recorded lectures and the remaining time will be used for interaction (question and answer).
- Tutorials will be conducted online; no recorded proceedings.
- Students have to attend the classes for their division. If you are in D1, you have to attend D1 classes.
- Attendance will be downloaded 5 min after the scheduled start of the class. If anybody joins the class after that, attendance will not be considered.

All the best