**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI-HYDERABAD CAMPUS**

**FIRST SEMESTER 2022-2023**

**COURSE HANDOUT- (QM I)**

*Date: 29.08.2022*

***Course No.* : PHY F345**

***Course Title* : Quantum Mechanics for Engineers**

***Instructor-in-Charge* : Subhash Karbelkar**

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# Scope and Objective:

The course mainly focuses on very essential concepts in Quantum mechanics that are required by engineers. It also covers few engineering applications. Throughout the course the problem-solving approach will be followed.

1. **Course Description:** The course covers the following topics: Wave particle duality; Schrödinger wave equation; probability and current densities; position and momentum operators; state space; expectation values of operators; commuting operators, Uncertainty relations; orthogonality and completeness of eigenfunctions; one dimensional potential problems; reflection and transmission; harmonic oscillator; time dependent Schrödinger equation; time evolution of stationary states; group velocity; crystals; one electron approximation; Bloch’s theorem; density of states; effective mass; band structure calculations; nanostructures: quantum wire, quantum well, quantum dots

**Text Book:**

**T1:** Quantum Mechanics for Scientists and Engineers by David Miller, Cambridge University Press

**Reference Books:**

Much of the course content can be found in most books on quantum mechanics. Two quantum mechanics books, which should be accessible to all with prerequisites, are:

**R1:** Quantum Physics (2nd. Edition), Stephen Gasiorowicz,

**R2:** Introduction to Quantum Mechanics (Second edition) by D J Griffiths, LPE, Pearson

**Course Plan**

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| --- | --- | --- | --- |
| **Number of lectures** | Learning Objectives | Topics to be covered | **Chapter in the Text Book** |
| 2 | Introduction | Origins of quantum mechanics | class notes |
| 2 | Wave particle duality |  |
| 4 | Schroedinger wave equation | Probability and current densities | 2.1-2.4 |
| 3 | Eigen-functions, eigen-values, expectation values, normalization | 2.7 |
| 2 | Particle in a box | Infinite square well potential | 2.6 |
| 3 | Finite potential barriers and wells, reflection and transmission | 2.8 |
| 4 | Harmonic oscillator | Eigen-values and eigen functions | 2.10 |
| 2 | Particle in linearly varying potential | Linear potentials without boundary, triangular potential well | 2.11 |
| 3 | Time evolution | Wave packets, group velocity, evolution of stationary states | 3.1 -3.7 |
| 3 | Operators and expectation values | Time evolution, Hamiltonian, position and momentum operators, Eigen-functions, eigen-values, expectation values, | 3.8 -3.14 |
| 2 | Electrons in crystals | One electron approximation, Bloch theorem, | 8.1-8.3 |
| 3 | Density of states and band structure | Density of states in k space, band structure | 8.4-8.5 |
| 3 | Effective mass theory | Effective mass approximation, density of states in energy, density of states in quantum well | 8.6-8.8 |
| 2 | Band structure | Kronig Penny model, k∙p model, Fermi’s golden rule | 8.9-8.10 |
| 2 | Nanostructures applications | Quantum wire, well and dots | Class notes |

**Evaluation Scheme:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EC No.** | **Evaluation Component** | Duration | Weightage **(%)** | **Date, Time** | **Nature of Component** |
| 1 | Quiz-1 | 50 Min. | 12.5 | TBA | Open Book |
| 2 | Mid Sem Test | 90 Min. | 35 | 04/11 3.30 - 5.00PM | Closed Book |
| 3 | Quiz-2 | 50 min | 12.5 | TBA | Open Book |
| 4 | Comprehensive Exam | 180 Min. | 40 | 28/12 AN | Closed Book |

**Chamber Consultation Hour: Chanber A202; hour:** To be announced later

**Notices:** Notices and solutions of Quizzes, Mid-Semester & Final Comprehensive Examination will be displayed on **CMS**.

**Make-up Policy:** In case of all pre-compre evaluation components, make up will be granted only on production of evidential documents with prior permission from the IC.

**Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-Charge**

##### **PHY F345**