DEPARTMENT OF PHYSICS

NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

COURSE PLAN – PART I			
Name of the programme and specialization	**M. Sc - I Semester & Physics**		
Course Title			
Course Code	**PH655**	**No. of Credits**	**4 (3 Theory + 1 Tutorials)**
Course Code of Pre-requisite subject(s)	**NIL**		
Session	**July 2019**	**Section (if, applicable)**	
Name of Faculty	**Dr. A. Chandra Bose**	**Department**	**Physics**
Email	**acbose@nitt.edu**	**Telephone No.**	**0431-250-3605**
Name of Course Coordinator(s) (if, applicable)	**Dr. M.C. Santhosh Kumar**		
E-mail	**santhoshmc@nitt.edu**	**Telephone No.**	**0431-250-3611**
Course Type	√ **Core course**	☐ **Elective course**	

Syllabus (approved in senate)

Objective: To introduce the mechanics of mater-waves necessary for uncovering the mysteries of matter at atomic scale. 2. To understand the spectrum of hydrogen. 3. To introduce various approximate methods useful for more complex problems.

Unit – I: Schrödinger Equation Inadequacy of classical theory – de-Broglie hypothesis of matter waves – Heisenberg's uncertainty relation – Schrödinger's wave equation – physical interpretation and conditions on wave function – eigenvalues and eigenfunctions – particle in a square-well potential – potential barrier – tunneling.

Unit – II: Operators and Eigenfunctions Linear operator – orthogonal systems and Hilbert space – expansion in eigenfunctions – Hermitian operators – canonical commutation – commutations and uncertainty principle – state with minimum uncertainty.

Unit – III: Solvable Problems Harmonic oscillator – operator method – Schrödinger equation for spherically symmetric potentials – angular momentum operator – condition on solutions and eigenvalues – spherical harmonics – rigid rotor – radial equation of central potential – hydrogen atom – degenerate states.

Unit – IV: Angular Momentum and Spin Eigenvalues of angular momentum J – matrix representation of J – electron spin – Stern – Gerlach experiment – Zeeman effect – addition of angular momentum – Clebsh-Gordan coeffecients – identical particles with spin – Pauli exclusion principle.

Unit – V: Approximation Methods Perturbation theory for non-degenerate states – removal of degeneracy – Stark effect – variation method – WKB approximation – Bohr-Summerfield quantum

condition –pertubative solution for transition amplitude – selection rules – Fermi Golden rule – scattering of a particle by a potential.

COURSE OBJECTIVES

- To introduce the mechanics of mater-waves necessary for uncovering the mysteries of matter at atomic scale.
- To understand the spectrum of hydrogen using solvable methods.

To introduce various approximate methods useful for more complex problems

COURSE OUTCOMES (CO)

Course Outcomes	**Aligned Programme Outcomes (PO)**
Students would become familiar with the: ✓ The students will be able to understand quantum mechanics solving microscopic domain ✓ Students can also appreciate mysteries of matter at atomic scale which are used in simple and complex problems. ✓ Students obtain in-depth knowledge on important quantum physics concepts.	➢ Obtain in depth knowledge on important Physics concepts. ➢ Carry out independent research work in interdisciplinary areas

COURSE PLAN – PART II

COURSE OVERVIEW

This course is offered to I year M.Sc. Physics students in the first semester. The course has 3 credit theory and 1 credit tutorials.

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	**Week/Contact Hours**	**Topic**	**Mode of Delivery**
1	1 - 3 weeks (Unit-I)	**Schrödinger Equation** - Schrodinger's wave equation – eigenvalues and eigenfunctions – superposition principle – interpretation of wave function – particle confined in one dimensional infinite square well potential - potential barrier –	Chalk and talk / power point presentation
2	4 - 6 Week (Unit-II)	tunneling **- Operators and Eigenfunctions**- Linear operator – orthogonal systems and Hilbert space-Expansion in eigenfunctions – Hermitian operators- different operators- canonical commutation- Dirac- Notations-commutations and uncertainty principle – state with minimum uncertainty.	Chalk and talk / power point presentation

3	7- 9 week (Unit-III)	**Solvable Problems** Harmonic oscillator – operator method- Schrödinger equation for spherically symmetric potentials -condition on solutions and eigenvalues – spherical harmonics – rigid rotor- Radial equation of central potential – hydrogen atom – degenerate states.	Chalk and talk / power point presentation
4	10-12 week (Unit-IV)	**Angular Momentum and Spin** - Eigenvalues of angular momentum **J** – matrix representation of **J** – electron spin - - Stern – Gerlach experiment – Zeeman effect – addition of angular momentum – Clebsh-Gordan coeffecients	Chalk and talk / power point presentation
5	13-15 weeks (Unit-V	**Approximation Methods** - Perturbation theory for non-degenerate states – removal of degeneracy – Stark effect – variation method - Pertubative solution for transition amplitude – selection rules – Fermi Golden rule – scattering of a particle by a potential.	Chalk and talk / power point presentation/ Seminar

COURSE ASSESSMENT METHODS (shall range from 4 to 6)

S.No.	Mode of Assessment	Week/Date	Duration	%Weightage
1	**I Cycle Test** (Descriptive Questions and Problems) (Portion-**Schrödinger Equation and Operators and Eigenfunctions**)	Last week of september 2019	**60 mins**	**20**
2	**II Cycle Test** (Descriptive Questions Problems) (Portion -**Solvable Problems and Angular Momentum and Spin**)	First week of November 2019	**60 mins**	**20**
3	**ASSIGNMENT/SEMINAR**	Before cycle tests	**-**	**5+5**
4	**End Semester*** (Whole Theory Syllabus)	As per Institute timetable	**180 mins** (Whole Theory Syllabus)	**50**
			Total	**100**
CPA	Compensation Assessment* (Units I to IV)	First week of December	60 mins	20

***mandatory; refer to guidelines**

ESSENTIAL READINGS : Textbooks, reference books, website addresses, journals, etc.

*1. **Text Books***

1. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill (1976).
2. J.L. Powell and B. Crasemann, Quantum Mechanics, Narosa Publishing House (1993).
3. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1999).
4. Quantum Mechanics, Aruldhas, Prentice Hall of India (2006).

Reference Books

1. L.I. Schiff, Quantum Mechanics, McGraw-Hill (1968).
2. D.J. Griffiths, Introduction to Quantum Mechanics, Pearson Education (2005).
3. N. Zettili, Quantum Mechanics: Concepts and Applications, John Wiley (2009).
4. L.D. Landau and E.M. Lifshitz, Quantum Mechanics (Non-relativistic Theory), 3rd edition, Elsevier (2011).

✓

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

- ✓ Feedback from the students will be collected after 16th week: on knowledge gained, subjects relevant to the course, methodology adopted, aspect of improvement, whether the topics fulfill the course outcome and program outcome.

COURSE POLICY (preferred mode of correspondence with students, compensation assessment policy to be specified)

MODE OF CORRESPONDENCE (email/ phone etc)

- ✓ Both e-mail and phone

COMPENSATION ASSESSMENT POLICY

- ✓ It is a test with duration of 60 minutes with 20% weightage

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- **At least 75% attendance in each course is mandatory.**
- **A maximum of 10% shall be allowed under On Duty (OD) category.**
- Students with **less than 65% of attendance** shall be prevented from writing the final assessment and **shall be awarded 'V' grade.**

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC

chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.

The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION

- ✓ Cell Phones should be turned-off in classroom. During the lecture using mobile phones will be treated as punishable dishonesty.
- ✓ The teachers can be contacted through phone or in person for clarifications by the student on a mutually convenient time or through e-mail: acbose@nitt.edu

FOR APPROVAL

-sd-	**-sd-**	**-sd-**
Course Faculty _____	**CC-Chairperson** _____	**HOD** _____

Guidelines:

a) The number of assessments for a course shall range from 4 to 6.

b) Every course shall have a final assessment on the entire syllabus with at least 30% weightage.

c) **One compensation assessment for absentees in assessments (other than final assessment) is mandatory. Only genuine cases of absence shall be considered.**

d) The passing minimum shall be as per the regulations.

B.Tech. Admitted in	P.G.

2018	2017	2016	2015	
35% or class average/2 whichever is greater.		Peak/3 or class average/2 whichever is lower		40%

e) Attendance policy and the policy on academic dishonesty & plagiarism by students are uniform for all the courses.

f) Absolute grading policy shall be incorporated if the number of students per course is less than 10.

g) Necessary care shall be taken to ensure that the course plan is reasonable and is objective.