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	Quantum Mechnaics		
Course Code	PH655	No. of Credits	4
Course Code of Pre-requisite subject(s)	NIL		
0Session	July 2018	Section (if, applicable)	
Name of Faculty	Dr. A. Chandra Bose	Department	Physics
Email	santhoshmc@nitt.edu	Telephone No.	0431-250-3605
Name of Course Coordinator(s) (if, applicable)	Dr. M.C. Santhosh Kumar		
E-mail	acbose@nitt.edu	Telephone No.	0431-250-3605
Course Type	[√] Core course	[ ] Elective course	

Syllabus (approved in BoS)

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-Sommerfeld 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 solving microscopic problems ✓ Understand basics of quantum concepts

COURSE PLAN – PART II

COURSE OVERVIEW

This course deals with the fundamentals related to quatum concepts and applications of quantum concepts to microscopic problems

COURSE TEACHING AND LEARNING ACTIVITIES

S.No.	Week/Contact Hours	Topic	Mode of Delivery
1	I week of August	**Schrödinger Equation** -Inadequacy of classical mechanics (black body radiation, photoelectric effect)	Chalk &Talk (C&T)
2	II week of August	**Schrödinger Equation** -wave and particle duality of radiation – de Broglie concept of matter waves – electron diffraction – Heisenberg's uncertainty principle	C&T
3	III week of August	**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 – tunneling	C&T
4	IV week of August	**Operators and Eigenfunctions**- Linear operator – orthogonal systems and Hilbert space-Expansion in eigenfunctions – Hermitian	C&T,

		operators- different operators	
5	I week of September	**Operators and Eigenfunctions**-– canonical commutation- Dirac-Notaions-commutations and uncertainty principle – state with minimum uncertainty.	C&T
6	II week of September	**Solvable Problems**Harmonic oscillator – operator method	C&T
7	IV week of September	**Solvable Problems**– Schrödinger equation for spherically symmetric potentials -condition on solutions and eigenvalues – spherical harmonics – rigid rotor	C&T
8	I week of October	**Solvable Problems**- Radial equation of central potential – hydrogen atom – degenerate states.	C&T
9	II week of October	**Angular Momentum and Spin** - Eigenvalues of angular momentum **J** – matrix representation of **J** – electron spin	C&T
10	III week of October	**Angular Momentum and Spin** - Stern – Gerlach experiment – Zeeman effect – addition of angular momentum – Clebsh-Gordancoeffecients	C&T
11	IV week of October	**Angular Momentum and Spin** - identical particles with spin – Pauli exclusion principle.	C&T
12	I week of November	**Approximation Methods** - Perturbation theory for non-degenerate states – removal of degeneracy – Stark effect – variation method	C&T
13	II week of November	**Approximation Methods** - WKB approximation – Bohr-Sommerfeld quantum condition	C&T
14	III week of November	**Approximation Methods** - Pertubative solution for transition amplitude – selection rules – Fermi Golden rule – scattering of a particle by a potential.	C&T
15	Dec 1st week	**Uncovered syllabus/any lacking in the syllabus will be done/retest**	
COURSE ASSESSMENT METHODS (shall range from 4 to 6)			

S.No.	Mode of Assessment	Week/Date	Duration	%Weightage
1	I Cycle test (Portion- **Schrödinger Equation and Operators and Eigenfunctions**)	II/III week of September	60 min	20
2	II cycle test (Portion -**Solvable Problems and Angular Momentum and Spin**)	III/IV week of October	60 min	20
3	**Assignment/Seminar**	October-November	Based on the activity	10 %
CPA	**Compensation Assessment***	November 4th week	60 min	
5	**Final Assessment***	Dec. 2nd week	180 min	50 %
Total Theory				**100%**

***mandatory; refer to guidelines**

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

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).

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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

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.