



**Ramniranjan Jhunjhunwala College of Arts,
Commerce and Science (Empowered Autonomous)
Ghatkopar (W), Mumbai 400086**

SYLLABUS FOR SEM - V

Program: B.Sc. Physics Major - DSC

Course Code:

**Sem V : RJDSCPHY351, RJDSCPHY352, RJDSCPHY353,
RJDSCPHY351**

**Sem V : RJDSCPHY361, RJDSCPHY362, RJDSCPHY363,
RJDSCPHY361**

**Credit Based Semester System w. e. f. the
Academic Year 2025 –2026**

**Syllabus for T.Y.B.Sc. Physics Major
(Choice Based Credit System w. e. f. academic year 2025-26 in compliance with NEP 2020)**

The revised syllabus in Physics as per credit based system for the Sem 3 B.Sc. Course will be implemented from the academic year 2025–2026. The syllabus is for the Semester V, Physics Major course. The systematic and planned curricula from these courses shall motivate and encourage learners to understand basic concepts of Physics. The National Education Policy 2020 aims at imparting skill-based learning and caters to the multiple entry and exit facility for the students thus empowering them to acquire knowledge at their pace. In the three-year UG program, the student has two exit options. Students also have the option of choosing the Honors program of four years of study in each discipline and later converting it to a five-year integrated PG degree program. As an undergraduate student, he/she learns the core subject (Major), a subject complementing the core subject (Minor), a course from another discipline (OEC or GEC), Vocational and Skill Enhancement course from the Major (VSEC). The remaining verticals under NEP 2020 are IKS (Indian Knowledge System), AEC (Ability Enhancement Course), VEC (Value Education Course) and with progressive three years of UG. A student also completes at different levels OJT (On Job Training), FP (Field Projects), CEP (Community Engagement Project), RP (Research Project) which helps him/her in understanding their roots, application of the knowledge for the benefit of self and the society. Vertical CC (Co-curricular activities and activities related to yoga and human well-being) helps in preparing youth with good character and interpersonal relationships.

Objectives:

- To develop analytical abilities towards real world problems.
- To familiarize with recent scientific and technological developments.
- To enrich knowledge through problem solving, hands-on activities, study visits, projects etc.

Course code	Title	Credits	Remarks
	Semester V		
RJDSCPHY351	Oscillatory Phenomena	2	
	Tutorials	1	Evaluation: 20 marks, replaces one IA, CE
RJDSCPHY352	Modern Physics	2	
	Tutorials	1	Evaluation: 20 marks, replaces one IA, CE
RJDSCPHY353	Advanced Thermodynamics	2	
	Tutorials	1	Evaluation: 20 marks, replaces one IA, CE
RJDSCPHY351	Advanced Laboratory 1	3	

Course code	Title	Credits	Remarks
	Semester VI		
RJDSCPHY361	Advanced Mechanics	2	
	Tutorials	1	Evaluation: 20 marks, replaces one IA, CE
RJDSCPHY362	Electrodynamics	2	
	Tutorials	1	Evaluation: 20 marks, replaces one IA, CE
RJDSCPHY363	Nuclei, Atoms, Molecules and Solids	2	
	Tutorials	1	Evaluation: 20 marks, replaces one IA, CE
RJDSCPHYP361	Advanced Laboratory 2	3	

SEMESTER-V

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics/Honors	6/8 semesters	V	Physics
Course Code	Title		
RJDSCPHY351	Oscillatory Phenomena		

Course outcomes:

After completion of the course students will be able to

- Mathematically formulate and understand simple oscillatory phenomena.
- Understand the common mathematical structure behind oscillations occurring in different fields.
- Understand the phenomenon of wave motion in strings.
- Understand the phenomenon of superposition of two harmonic waves.

Learning outcomes:

After completion of the unit students will be able to

- Draw resultant of superposition of two collinear SHMs under various phase difference conditions.
- Verify the resultant pattern of superposition of two perpendicular SHMs graphically.
- Differentiate between collinear and perpendicular harmonic oscillations.
- Understand the concept of phase and group velocity.
- Understand the concept of transverse waves on strings.
- Differentiate between progressive and standing waves.

Evaluation scheme:

Internal Assessment (continuous evaluation)	Semester End Exam
40%	60%
Will consist of tests, assignments, projects, participation and other schemes with the permission and suggestions of the Exam Committee.	Written exam with a marking scheme suitable to the topics. This marking scheme / paper pattern will be discussed by the teacher while conducting the course.
The evaluation scheme may be modified as per suggestions and instructions of the Exam Committee.	

SEMESTER V		
Physics Paper 1 RJDSCPHY351 Oscillatory Phenomena		
Unit I	Differential equations and Fourier Series	15 hours
1.	Differential equations: Introduction, Ordinary differential equations, First order homogeneous and non- homogeneous equations with variable coefficients, Exact differentials, General first order Linear Differential Equation, Second-order homogeneous equations with constant coefficients. Problems depicting physical situations like LC and LR circuits, Transient response of circuits: Series LR, CR, LCR circuits. Growth and decay of currents/charge.	
	HK-12.1, 12.2, 12.6, 12.7, 12.8, 12.10, 12.11, 12.12, 12.13, 13.3, 13.6, 13.15.	
2.	Fourier Series: Introduction, Fourier Cosine and sine series.	
	HK -11.1, 11.2, 11.3, 11.4, 11.5, 11.6.	
Unit II	Waves and Oscillations	15 hours
1.	Oscillations, The Simple Harmonic Oscillator, Two Body Oscillations, Damped, Harmonic Motion, Forced Oscillations and Resonance. Compound pendulum: Expression for period, maximum and minimum time period, centres of suspension and oscillations, reversible compound pendulum, compound pendulum and simple pendulum-a relative study.	
	RH: 17.1-17.9	
2.	Wave Motion: Characteristics of wave motion, Transverse wave motion, Longitudinal wave motion, Properties of Longitudinal Progressive waves, Differential equation of Wave Motion, Wave velocity and Group velocity, Stationary waves, Properties of stationary waves, Transverse waves on a string	
	SB: 4.3, 4.4, 4.5, 4.8, 4.12, 12.1, 6.1, 6.2, 7.2	

	TUTORIAL	15 hours
	Tutorials will involve quick revision, clearing students' doubts and solving some problems on the material taught in the lectures. The tutorials will be used to identify weak students. Such students can be separated (by giving good students additional problems to solve on their own) and paid more attention. Scheme of Evaluation (for tutorials): Each student will be assigned marks out of 10 for every tutorial (s)he has attended. Marks can be allotted based on the student's participation/ interaction during the tutorial. 1 mark will be reserved for an original thought either in the form of an answer or a question. At the end of the semester, the maximum marks in the 80% of the tutorials will be scaled down to 20 marks which will constitute 50% of the internal evaluation for the course.	
References:	1. RH: Resnick and Halliday : Physics – I 2. Mechanics – H. S. Hans and S. P. Puri, Tata McGraw Hill (2nd ED.) 3. SB: Waves and Oscillations, N Subrahmanyam and Brij Lal, Vikas Publishing House, 2nd revised Edition 4. HK Das and ML Boas	
Additional References:	1. Classical mechanics by Kleppener , Kollenkov 2. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.	

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics/Honors	6/8 semesters	V	Physics
Course Code	Title		
RJDSCPHY352	Modern Physics		

Objectives:

- To develop analytical abilities towards real world problems.
- To familiarize with recent scientific and technological developments related to modern physics.
- To enrich knowledge through problem solving, hands-on activities, study visits, projects etc.

Course Outcomes:

On successful completion of this course students will be able to:

1. Understand modern physics.
2. Understand how modern physics developed.
3. Understand the concepts of special relativity, quantum mechanics and be able to perform calculations using them.
4. Understand experiments related to modern physics.
5. Understand the basic mathematical concepts used in modern physics.
7. Demonstrate quantitative problem solving skills in all the topics covered.

Evaluation scheme:

Internal Assessment (continuous evaluation)	Semester End Exam
40%	60%
Will consist of tests, assignments, projects, participation and other schemes with the permission and suggestions of the Exam Committee.	Written exam with a marking scheme suitable to the topics. This marking scheme / paper pattern will be discussed by the teacher while conducting the course.
The evaluation scheme may be modified as per suggestions and instructions of the Exam Committee.	

SEMESTER V		
Physics Paper 2 RJDSCPHY352 Modern Physics		
Unit I	Modern Physics	15 hours
1.	Special Relativity : Special Relativity, Time Dilation, Doppler Effect, Length Contraction, Twin Paradox, Relativistic Momentum, Mass and Energy, Energy and Momentum	
	AB : 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 1.8, 1.9	
2.	Particle Properties of Waves : Electromagnetic Waves, Blackbody Radiation, Photoelectric Effect, What Is Light?, X-Rays, X-Ray Diffraction, Compton Effect	
	AB : 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7	
Unit II	Wave Properties of Particles and Quantum Mechanics	15 hours
1.	Wave Properties of Particle : De Broglie Waves, Waves of What?, Describing a Wave, Phase and Group Velocities, Particle Diffraction, Particle in a Box, Uncertainty Principle I, Uncertainty Principle II, Applying the Uncertainty Principle	
	AB : 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9	
2.	Quantum Mechanics : Quantum Mechanics, The Wave Equation, Schrödinger's Equation: Time-Dependent Form, Linearity and Superposition, Expectation Values, Operators, Schrödinger's Equation: Steady-State Form, Particle in a Box, Tunnel Effect	
	AB : 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.10	
	TUTORIAL	15 hours
	Tutorials will involve quick revision, clearing students' doubts and solving some problems on the material taught in the lectures. The tutorials will be used to identify weak students. Such students can be separated (by giving good students additional problems to solve on their own) and paid more attention. Scheme of Evaluation (for tutorials):	

	Each student will be assigned marks out of 10 for every tutorial (s)he has attended. Marks can be allotted based on the student's participation/ interaction during the tutorial. 1 mark will be reserved for an original thought either in the form of an answer or a question. At the end of the semester, the maximum marks in the 80% of the tutorials will be scaled down to 20 marks which will constitute 50% of the internal evaluation for the course.	
References:	AB: Concepts of Modern Physics (Sixth Edition), Arthur Beiser, Published by McGraw-Hill.	
Additional References:	1) Modern Physics, R. Murugesan & K. Shivprasath, 18th Edition, S. Chand & Co. 2) Introduction to Special Theory of Relativity, Robert Resnick, John Wiley, Publication 3) Kenneth Krane, Modern Physics, 3rd or 4th Edition, John Wiley	

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics/Honors	6/8 semesters	V	Physics
Course Code	Title		
RJDSCPHY353	Advanced Thermodynamics		

Course outcomes: From this course, the students are expected to learn some mathematical techniques required to understand thermodynamic phenomena at the undergraduate level and get exposure to important ideas of statistical mechanics.

Learning outcomes:

1. The student will understand the relationship between the entropy and irreversibility and also be able to derive relationships between different thermodynamic variables using Maxwell's relations.
2. The student will understand the thermodynamics of the first order phase transitions.
3. The student will understand the various TdS equations and be able to use them in calculating thermodynamic properties.
4. The student will be able to work with various energy functions and transform one into another.

Evaluation scheme:

Internal Assessment (continuous evaluation)	Semester End Exam
40%	60%
Will consist of tests, assignments, projects, participation and other schemes with the permission and suggestions of the Exam Committee.	Written exam with a marking scheme suitable to the topics. This marking scheme / paper pattern will be discussed by the teacher while conducting the course.
The evaluation scheme may be modified as per suggestions and instructions of the Exam Committee.	

SEMESTER V		
Physics Paper 3 RJDSCPHY353 Advanced Thermodynamics		
Unit I	Mathematical Methods in Thermodynamics	15 hours
1.	Partial Differentiations, Entropy and irreversibility, Characteristic Functions Enthalpy, Helmholtz and Gibbs Functions, Two Mathematical Theorems, Maxwell's Relations, TdS Equations, Internal-Energy Equations, Heat-Capacity Equations	
	ZD: 8.7, 10.1-10.8	
Unit II	Open Thermodynamic Systems	15 hours
1.	Joule-Thomson Expansion, Liquefaction of Gases by the Joule-Thomson Expansion, First-Order Phase Transitions; Clausius-Clapeyron Equation, Clausius-Clapeyron Equation and Phase Diagrams, Clausius-Clapeyron Equation and the Carnot Engine, Chemical Potential, Open Hydrostatic Systems in Thermodynamic Equilibrium	
	ZD: 11.1-11.7	

	TUTORIAL	15 hours
	Tutorials will involve quick revision, clearing students' doubts and solving some problems on the material taught in the lectures. The tutorials will be used to identify weak students. Such students can be separated (by giving good students additional problems to solve on their own) and paid more attention. Scheme of Evaluation (for tutorials): Each student will be assigned marks out of 10 for every tutorial (s)he has attended. Marks can be allotted based on the student's participation/ interaction during the tutorial. 1 mark will be reserved for an original thought either in the form of an answer or a question. At the end of the semester, the maximum marks in the 80% of the tutorials will be scaled down to 20 marks which will constitute 50% of the internal evaluation for the course.	
References:	1. ZD: Heat and thermodynamics: M. W. Zemansky and Richard H. Dittman (McGraw- Hill Science) 2. Thermodynamics, Statistical Thermodynamics and Kinetics: T. Engel and P. Reid (Pearson).	
Additional References:	1. Statistical Physics (In SI Units): Berkeley Physics Course - Vol.5, F. Reif, 2. Schaums Outline of Thermodynamics for Engineers, Fourth Edition - 2019 by Potter, Merle C., Somerton, Craig W. 3. An Introduction To Thermal Physics, Daniel V. Schroeder	

SEMESTER-V

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics / Honors	6 / 8 semesters	V	Physics
Course Code	Title		
RJDSCPHYP351	Advanced Laboratory 1		

Course Outcome:

On successful completion of this course students will be able to:

- i) To demonstrate their practical skills.
- ii) To understand and practice the skills while doing physics practical.
- iii) To understand the use of apparatus.
- iv) To correlate their physics theory concepts through practical.
- v) Understand the concepts of errors and their estimation.

Learning outcomes:

On successful completion of this course students will be able to learn :

- i) Practical skills.
- ii) The skills while doing physics practical.
- iii) The use of apparatus.
- iv) Concepts of errors and their estimation.

A. Regular Experiments:

B. Skill Experiments:

C. Demonstration Experiments:

LIST OF EXPERIMENTS

Sr. No.	Name of the Experiments
1	Kater's Pendulum
2	Bar Pendulum
3	Lee's Method

4	Coupled Oscillator and resonance
5	Colpitts oscillator
6	Concept of beats
7	Log decrement
8	LCR - resonance
9	Modern physics skills 1
10	Modern physics skills 2
11	Modern physics demo 1
12	Modern physics demo 2
13	h/e using photocell or LED
14	Frank-Hertz
15	Simulation 1:
16	Simulation 2:
17	Michelson Morley Interferometer
18	Millikan oil drop experiment
19	Solving first and second order ODEs using python libraries
20	Solving wave equation in one dimension using python

Note:

1. Any new experiment relevant to the syllabus may be added at any time.
2. The skill experiments are required to be performed as a part of laboratory orientation.
3. Around 6 to 8 experiments from the list of the Regular experiments should be completed and reported in the journal, in the first semester.
4. A mini project related to the topics in the syllabus should be done by the student
5. A Certified Journal is a must to be eligible to appear for the semester end practical examination.

Scheme of Examination:

We will follow a scheme of continuous evaluation for the experiments conducted in this course. The marking scheme will be as follows:

- a. 40% marks for performing experiments
- b. 10% marks for Journal
- c. 30% marks for Viva
- d. 20% marks for mini project

SEMESTER-VI

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics/Honors	6/8 semesters	VI	Physics
Course Code	Title		
RJDSCPHY361	Advanced Mechanics		

Course Outcomes: The course will introduce students to advanced concepts in Newtonian Mechanics by covering topics such as central forces, fluid dynamics and rigid body dynamics which are not covered in the first course in Mechanics.

Learning outcomes: On successful completion of this course students will be able to:

1. understand the kinds of motions that can occur under a central potential and their applications to planetary orbits.
2. appreciate the effect of moving coordinate system, rectilinear as well as rotating.
3. Grasp simple concepts from fluid mechanics and understanding of the dynamics of rigid bodies is also expected.

Evaluation scheme:

Internal Assessment (continuous evaluation)	Semester End Exam
40%	60%
Will consist of tests, assignments, projects, participation and other schemes with the permission and suggestions of the Exam Committee.	Written exam with a marking scheme suitable to the topics. This marking scheme / paper pattern will be discussed by the teacher while conducting the course.
The evaluation scheme may be modified as per suggestions and instructions of the Exam Committee.	

SEMESTER VI		
Physics Paper 1 RJDSCPHY361 Advanced Mechanics		
Unit I	(redistribution of topics)	15 hours
1.	Center of Mass, Motion of the Center of Mass, Linear momentum of a Particle, Linear momentum of a System of Particles, Linear momentum w.r.t. CM coordinate (i.e shift of origin from Lab to CM), Conservation of Linear Momentum, Some Applications of the Momentum Principle, System of Variable Mass (more problems)	
	RH: 6.2, 6.4, 6.5, 7.4, 7.6	
2.	Moving origin of coordinates, Rotating coordinate systems, Laws of motion on the rotating earth, The Foucault pendulum, Larmor's theorem.	
	KRS: 3.13 - 3.15, 7.1 - 7.5	
3	Kinematics of moving fluids, Equation of motion for an ideal fluid, Conservation laws for fluid motion, Steady flow.	
	KRS : 8.6 to 8.9	
Unit II		15 hours
1.	Motion under a central force, the central force inversely proportional to the square of the distance, Elliptic orbits, The Kepler problem.	
	KRS: 3.13 - 3.15, 7.1 - 7.5.	
2.	Rigid dynamics: introduction, degrees of freedom, rotation about an axis: orthogonal matrix, Euler's theorem, Eulerian angles, inertia tensor, angular momentum of rigid body, Euler's equation of motion of rigid body, free motion of rigid body, motion of symmetric top (without notation).	
	PVP: 16.1 to 16.10	

	TUTORIAL	15 hours
	Tutorials will involve quick revision, clearing students' doubts and solving some problems on the material taught in the lectures. The tutorials will be used to identify weak students. Such students can be separated (by giving good students additional problems to solve on their own) and paid more attention. Scheme of Evaluation (for tutorials): Each student will be assigned marks out of 10 for every tutorial (s)he has attended. Marks can be allotted based on the student's participation/ interaction during the tutorial. 1 mark will be reserved for an original thought either in the form of an answer or a question. At the end of the semester, the maximum marks in the 80% of the tutorials will be scaled down to 20 marks which will constitute 50% of the internal evaluation for the course.	
References:	PVP: Classical Mechanics, P. V. Panat (Narosa). KRS: Mechanics: Keith R. Symon, (Addison Wesley) 3rd Ed. RH: Resnick and Halliday : Physics – I	
Additional References:	BO: Classical Mechanics- a Modern Perspective: V. D. Barger and M.G. Olsson. (Mc Graw Hill International 1995 Ed.) An Introduction to Mechanics: Daniel Kleppner & Robert Kolenkow Tata Mc Graw Hill (Indian Ed. 2007).	

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics/Honors	6/8 semesters	VI	Physics
Course Code	Title		
RJDSCPHY362	Electrodynamics		

Course Outcomes: The course will introduce students to vector algebra and different curvilinear coordinate systems and dirac delta function. Introduction to vector calculus and vector integration(single,double and triple).This course will cover the understanding of electricity and magnetism with the help of vector algebra which are not covered in the first course in Electricity and Magnetism.

Learning outcomes:On successful completion of this course students will be able to:

1. understand the vector algebra, dirac delta functions and be able to solve multi variable integration.
2. Helps to understand different coordinate systems.
3. Understanding of Electricity and magnetism with the help of vector algebra is expected.

Evaluation scheme:

Internal Assessment (continuous evaluation)	Semester End Exam
40%	60%
Will consist of tests, assignments, projects, participation and other schemes with the permission and suggestions of the Exam Committee.	Written exam with a marking scheme suitable to the topics. This marking scheme / paper pattern will be discussed by the teacher while conducting the course.
The evaluation scheme may be modified as per suggestions and instructions of the Exam Committee.	

SEMESTER VI		
Physics Paper 2 RJDSCPHY362 Electrodynamics		
Unit I	Vector algebra: Vector Calculus and Curvilinear Coordinate system	15 hours
1.	Vector algebra and calculus, product rules, Second derivatives Line, Surface and Volume Integrals,	
	DG: 1.2.1, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 1.2.5, 1.2.6, 1.2.7, 1.3.1	
2.	The Fundamental Theorem of Calculus, The Fundamental Theorem of Gradient, The Fundamental Theorem of Divergence, The Fundamental Theorem of Curl (Statement and Geometrical interpretation is included, Proof of these theorems are omitted). Problems based on these theorems are required to be done	
	DG: 1.3.2, 1.3.3, 1.3.4, 1.3.5	
3.	Curvilinear Coordinates: Cylindrical Coordinates, Spherical Coordinates, The Dirac Delta Function.	
	DG: 1.4, 1.5	
Unit II	Electrostatics and Magnetostatics	15 hours
1.	- Gauss law, The divergence of $\mathbf{E}$, Applications of Gauss' law, The curl of $\mathbf{E}$. Introduction to potential, Comments on potential, The potential of a localized charge distribution. Poisson's equation and Laplace's equation. Solution and properties of 1D Laplace equation. Properties of 2D and 3D Laplace equation (without proof). - Boundary conditions and Conductors. The classic image problem- point charge and grounded infinite conducting plane and conducting sphere.	
	DG : 2.2, 2.3, 3.1, 3.2	
2.	Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics, A deceptive parallel, Susceptibility,	

	Permittivity, Dielectric constant and relation between them, Energy in dielectric systems.	
	DG : 4.1, 4.2, 4.3, 4.4	
3.	Ampere's law, Straight-line currents, The Divergence and Curl of $\mathbf{B}$, Applications of Ampere's Law in the case of a long straight wire and a long solenoid, Comparison of Magnetostatics and Electrostatics, Magnetic Vector Potential.	
	DG: 5.3, 5.4	
4.	Magnetization, Bound currents and their physical interpretation, Ampere's law in magnetized materials, A deceptive parallel, Magnetic susceptibility and permeability.	
	DG: 6.1.4, 6.2, 6.3, 6.4	
	TUTORIAL	15 hours
	Tutorials will involve quick revision, clearing students' doubts and solving some problems on the material taught in the lectures. The tutorials will be used to identify weak students. Such students can be separated (by giving good students additional problems to solve on their own) and paid more attention. Scheme of Evaluation (for tutorials): Each student will be assigned marks out of 10 for every tutorial (s)he has attended. Marks can be allotted based on the student's participation/ interaction during the tutorial. 1 mark will be reserved for an original thought either in the form of an answer or a question. At the end of the semester, the maximum marks in the 80% of the tutorials will be scaled down to 20 marks which will constitute 50% of the internal evaluation for the course.	
References:	DG: Introduction to Electrodynamics, David J. Griffiths (3rd Ed) Prentice Hall of India	
Additional References:	Introduction to Electrodynamics: A. Z. Capria and P. V. Panat, Narosa Publishing House.	
	Engineering Electrodynamics: William Hayt Jr. & John H. Buck (TMH).	

	Foundations of Electromagnetic Theory: Reitz, Milford and Christy.	
	Electricity and Magnetism: Edward M. Purcell & David J. Morin(3rd edition), Cambridge university press	

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics/Honors	6/8 semesters	VI	Physics
Course Code	Title		
RJDSCPHY363	Nuclei, Atoms, Molecules and Solids		

Course Outcomes:

On successful completion of this course students will be able to understand/get:
the application of quantum mechanics in atomic physics

1. effect of magnetic field on atoms and its application
2. molecular physics and its applications and an insight into spectroscopy.
3. the fundamentals of nuclear physics as well as considering some of the most important applications of nuclear physics. Topics to be studied will include nuclear forces, nuclear models and nuclear energy. The lecture course will be integrated with problem solving classes.
4. the different structures of crystals and to understand types of characterization of crystals and its applications. Also to understand various theories of behaviour of electron in material. The course will also focus on the various examples of current solid-state research.
5. the basic mathematical concepts and applications of them in physical situations.
6. demonstrate quantitative problem solving skills in all the topics covered.

Learning Outcomes:

On successful completion of this course students will be able to understand

1. the basic concepts of nuclear physics, some introductory terminology, units and dimensions & chronology of some of the major events in nuclear physics. Also students can express the nuclear radioactivity and nuclear energy.
2. various types of crystal structures and symmetries and understand the Bragg's X-ray diffraction in crystals. Would also learn to relate the crystalline structure to X-ray diffraction data and the reciprocal lattice. Also able to learn about the concept of Fermi energy.
3. the importance of electron spin, symmetric and antisymmetric wave functions and vector

- atom model and types of coupling
- the Zeeman effect and its quantum and classical theory
 - molecular spectroscopy concepts
 - quantum and classical theory of Raman effect and ESR and NMR techniques as applications

Evaluation scheme :

Internal Assessment (continuous evaluation)	Semester End Exam
40%	60%
Will consist of tests, assignments, projects, participation and other schemes with the permission and suggestions of the Exam Committee.	Written exam with a marking scheme suitable to the topics. This marking scheme / paper pattern will be discussed by the teacher while conducting the course.
The evaluation scheme may be modified as per suggestions and instructions of the Exam Committee.	

SEMESTER VI		
Physics Paper 3 RJDSCPHY363 Nuclei, Atoms, Molecules and Solids		
Unit I	Atoms and Molecules	15 hours
1.	Hydrogen atom: Schrödinger's equation for Hydrogen atom, Separation of variables, Quantum Numbers: Total quantum number, Orbital quantum number, Magnetic quantum number. Angular momentum, Electron Spin: The Stern- Gerlach experiment, Spin orbit coupling, Hund's Rule, Total angular momentum, Vector atom model, L-S and J-J coupling. Origin of spectral lines, Selection rules.	
	AB: 9.1 to 9.9, 10.1 to 10.3, 10.6 to 10.9, 11.1 and 11.2	
2.	The normal Zeeman effect and its explanation (Classical and Quantum), The Lande g factor, Anomalous Zeeman effect	
	SA: 9.14, 9.15, 9.16, 9.17	

3	Molecular Spectra (Diatomic Molecules): Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational-Rotational spectra, IR and Microwave spectroscopy	
	AB : 14.1, 14.3, 14.5, 14.7 BM : 6.11, 6.1.3	
4.	Raman Effect: Quantum Theory of Raman effect, Classical theory of Raman effect, Pure Rotational Raman spectra: Linear molecules, ESR and NMR spectrometer	
	BM : 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.3.1	
Unit II	Nuclei and solids	15 hours
1.	Nuclear physics: Properties of nucleus: (Composition of nucleus, Nuclear size and density, Nuclear charge, Atomic mass and atomic mass unit, Nuclear angular & magnetic dipole moment, Mass defect and binding energy), Radioactivity: (Nuclear stability, Radioactivity, law of radioactivity, application, carbon dating), Nuclear forces & model: (Introduction, mesons theory, classification of elementary particles, quarks, liquid drop model, weizacher's semi empirical mass formula (no derivation)), Nuclear energy: (Nuclear fission, chain reaction, Nuclear reactor, Nuclear fusion, stellar energy)	08 hours (02+02+02+02)
	DCT: 18.1, 18.2, AB: 13.5, SBP: 5.1, 5.3. SBP: 1.i.4, 6.6 to 6.9, 9.6, 9.7.	
2.	Solid State physics: Crystallography: (Crystals, Crystal lattice, unit cell, primitive and non-primitive cells, The fourteen Bravais lattices and the seven crystal systems, SC, BCC, FCC, HCP, elements of symmetry, nomenclature of crystal directions and crystal planes, Miller Indices, spacing between the planes of the same Miller indices) Free electron theory of metals: (Classical free electron theory of metals, features, Drawbacks, Quantum theory of free electrons, features, drawbacks, Fermi Dirac	07 hours (04+03)

	distribution, Fermi energy and electronic distribution in solids)	
	MAO: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.6 SOP: 6.2,6.3,6.4, 6.5, 6.14, 6.15, 6.16, 6.17, 6.18, 6.20	
	TUTORIAL	15 hours
	Tutorials will involve quick revision, clearing students' doubts and solving some problems on the material taught in the lectures. The tutorials will be used to identify weak students. Such students can be separated (by giving good students additional problems to solve on their own) and paid more attention. Scheme of Evaluation (for tutorials): Each student will be assigned marks out of 10 for every tutorial (s)he has attended. Marks can be allotted based on the student's participation/ interaction during the tutorial. 1 mark will be reserved for an original thought either in the form of an answer or a question. At the end of the semester, the maximum marks in the 80% of the tutorials will be scaled down to 20 marks which will constitute 50% of the internal evaluation for the course.	
References:	AB: Perspectives of Modern Physics : Arthur Beiser McGraw Hill. BM: Fundamentals of Molecular Spectroscopy : C. N. Banwell & E. M. McCash (TMH).(4th Ed.) SA: SBP: Nuclear Physics, S.B. Patel (Wiley Eastern Ltd.). DCT: Nuclear Physics, D. C. Tayal (Himalayan Publishing House) MAO: Elementary Solid State Physics-Principles and Applications: M. Ali Omar,, 2012. SOP: S. O. Pillai, 6th Ed, Wiley Eastern Ltd.	
Additional References:	1. Atomic Physics (Modern Physics): S.N.Ghoshal. S.Chand Publication (for problems on atomic Physics). 2. GA: Molecular structure and spectroscopy : G Aruldas (2nd Ed) PHI learning Pvt Ltd.	

SEMESTER-VI

Name of the Program	Duration	Semester	Subject	Credits
B.Sc. in Physics / Honors	6 / 8 semesters	VI	Physics	3
Course Code	Title			
RJDSCPHYP361	Advanced Laboratory 2			

Course Outcome:

On successful completion of this course students will be able to:

- i) To demonstrate their practical skills.
- ii) To understand and practice the skills while doing physics practical.
- iii) To understand the use of apparatus.
- iv) To correlate their physics theory concepts through practical.
- v) Understand the concepts of errors and their estimation.

Learning outcomes:

On successful completion of this course students will be able to learn :

- Students will develop practical skills
- They will be able to understand theoretical concepts better

A. Regular Experiments:

B. Skill Experiments:

C. Demonstration Experiments:

LIST OF EXPERIMENTS

Sr. No.	Name of the Experiments
1	Gyroscope
2	Venturimeter
3	Finding center of mass of arbitrary shaped objects

4	Study of collisions using tracker
5	Centre of mass of system of particles using tracker
6	
7	Cloud chamber
8	GM counter
9	Hall Effect
10	Band Gap
11	Thermistor
12	Log Amplifier - eta factor of diode
13	Rydberg constant
14	Zeeman Effect
15	
16	Helmholtz coil (Quinkes method)
17	Hysteresis
18	Self and Mutual Inductance without (BG)
19	Eddy current - Magnetic braking for different materials
20	Dielectric constant of different media - using microammeter
21	
22	
23	
24	
25	

Note:

1. Any new experiment relevant to the syllabus may be added at any time.
2. The skill experiments are required to be performed as a part of laboratory orientation.
3. Around 6 to 8 experiments from the list of the Regular experiments should be completed and reported in the journal, in the first semester.
4. A mini project related to the topics in the syllabus should be done by the student
4. A Certified Journal is a must to be eligible to appear for the semester end practical examination.

Scheme of Examination:

We will follow a scheme of continuous evaluation for the experiments conducted in this course. The marking scheme will be as follows:

- a. 40% marks for performing experiments
- b. 10% marks for Journal
- c. 30% marks for Viva
- d. 20% marks for mini project

RULES AND REGULATIONS REGARDING ASSESSMENT AND EVALUATION

FOR FY UNDER NEP FROM A.Y. 2023-2024 ONWARDS-

1. A learner appearing for first year examination under NEP will have **maximum of 22 credits** and examinations will be of **maximum 550 marks**.

2. Courses having **2 credits, 3 credits and 4 credits** will have examinations of **50, 75, 100 marks** respectively.

3. With regard to Major Course, Minor Course and OEC:

Continuous evaluation of 40-60 adopted under autonomy (2018) shall continue for all the courses; for the courses with 2 credits and 50 marks, Internal is of 20 marks (only one IA) and External 30 marks (SEE); while the courses with 3 credits and 75 marks, it is 25 marks (only one IA) and 50 marks (SEE). In case of courses of 100 marks, the break up of marks will be 40 marks (IA) and 60 marks (SEE).

4. With regard to IKS, VSEC (VSC and SEC), AEC, VEC:

These will be of 2 Credits each and of 50 marks. Continuous evaluation of 40-60 wherein Internal is of 20 marks and SEE of 30 marks or Only one SEE of 50 marks or continuous evaluation of more than one test by the respective coordinating department or as directed by the EC.

5. With regard to CC:

Vertical of CC shall also be more like a **continuous evaluation** where a student will be awarded marks on the basis of **his / her participation in the co-curricular activities of the department / other departments / associations / extension activities / intercollegiate events and Jeevan Kaushal**. A workbook will be provided to a student to keep a record of his / her participation and will be duly signed by the concerned teachers.

6. Duration of examinations:

- An IA exam of 20/25 marks shall be of duration of 30 minutes.
- An SEE exam of 30 marks (offline) shall be of duration of 1 hour.
- An SEE exam of 50 marks (offline) shall be of duration of 1 ½ hour.
- An SEE exam of 50 marks (online MCQ) shall be of 60 minutes.
- An SEE exam of 60 marks (offline) shall be of duration of 2 hours.

7. There shall be **combined passing of Internals and SEE** in a given paper with a **minimum passing percentage of 40**.

8. **Appearing for SEE** for every paper is **compulsory** irrespective of the performance in the Internals examinations. A student absent in SEE will be thus declared failing in a given subject.

9. There shall be provision for supplementary examination for the benefit of students who miss their SEE on grounds of medical emergency or representing college at the national level event or any other equivalent event with a special permission granted by the Head of the institution.

10. There shall be no Additional Examinations for any of the Semesters except for the Semester V wherein one chance of credit improvement in Semester V shall be given before the Learner appears for the final Semester VI Examination.

11. A learner appearing for first year exam under NEP shall have examination of maximum **550 marks** to which effect **ATKT** is allowed for **maximum of 200 marks** corresponding to **failing in 3 / 4 courses** but must have passed in at least one Theory course of Major / Minor.

FOR SY AND TY-

12. For the SY (2023-2024) and TY (2023-2024 and 2024-2025) programs, 40 – 60 pattern of continuous evaluation continues. However, Internal 40% as 20 + 20 is revised from AY 2023-24 as 15 + 25 wherein, 15 marks of assignment and 25 marks of MCQs or any other mode of evaluation as decided by the respective department shall be implemented. Rest of the Rules and Regulations continues as earlier.

13. Ordinances **5042A, 5043A & 5044A, 5045A, 5046A, 5048A&B, 5049A, 5050A** and **0.229A** adopted under autonomy are to accepted as its under NEP. (Next Page)

ORDINANCES ADOPTED ON EXAMINATIONS CONDUCTED UNDER AUTONOMY

ORDINANCE NUMBER	MATTER OF REFERENCE
5042A	Grace Marks for passing in each head of passing (Theory/ Practical/ Oral/ Sessional)
5043A, 5044A	Grace marks for getting higher Class/ Grade (Grade Jump)
5045A	Condonation
5046A	Moderation
5048A&B	Amendments of Results (Due to errors, Due to fraud, malpractices etc.)
5049A	Appointment of paper setters, Examiners, Senior supervisors and conduct of examination etc.
5050A	Ordinance regarding Unfair means resorted to by the Student
0.229A	Benefit of 10 marks under NSS/ NCC/ LLLS/ SPORTS

Explanation:

Ordinance 5042A: *the benefit of gracing of marks under the ordinance shall be applicable only if the candidate passes the entire examination of semester/year.*

Ordinance 5043A, 44A: *the benefit of gracing of marks under the ordinance shall be applicable only if the candidate passes in all the subjects and heads of the examination without the benefit of either gracing or condonation rules and shall be given for maximum of 1% of the aggregate marks of the examination or up to 10 marks, whichever is less.*

Ordinance 5045A: *the benefit of gracing of marks under the ordinance shall be applicable only if the candidate fails in only one head of passing and his/her deficiency of marks in such head of passing may be condoned by not more than 1% of the aggregate marks of the examination or 10% of the total number of marks of that head of passing in which he/she is failing, whichever is less.*
Condonation of deficiency of marks be shown in the statement of marks in the form of asterisk and Ordinance number.

Ordinance 5046A: *the ordinance shall be applicable as per the detailed scheme of moderation released by the University of Mumbai via its adaptation in totality.*

Where marks awarded by the moderator vary from those awarded by original examiner, the marks awarded by the moderators shall be taken as final.

Ordinance 5048A&B: *section (A) of the ordinance is applicable to the case where it is found that the result of an examination has been affected by errors, the Controller of Examination shall have power to amend such result provided the errors are reported/ detected within 6 months from the date of declaration.*

Error means –

(a) Error in computer/ data entry, printing or programming and the like.

(b) Clerical error, manual or machine in totalling or entering of marks on mark list/ register.

(c) Error due to negligence or oversight of examiner or any other person connected with evaluation, moderation and result preparation.

Section (B) of the ordinance is applicable in any case where the result of an examination has been ascertained and published and it is found that such result has been affected by any malpractices, fraud or any other improper conduct whereby an examinee has benefited and that such examinee has been party of privy to or connived at such malpractice, fraud or improper conduct.

Ordinance 5049A: *the ordinance shall be applicable as per the guidelines of University of Mumbai.*

Ordinance 5050A: *the convener of the Unfair means committee shall take appropriate disciplinary action against the student/s using, attempting to use, instigating or allowing to use unfair means at the examination applying the ordinance as per the guidelines of University of Mumbai.*

Ordinance 0.229A: *the ordinance shall be applicable to the candidate for his/her satisfactory completion of NSS/NCC/DLLE/SPORTS. Benefit of 10 marks be shown in the Statement of Marks in the form of hashtag and Ordinance number.*

Dr. Himanshu G. Dawda
Principal, Chief Controller of Examination

Maj. Pravin G. Nayak
Controller of Examination