R. J. COLLEGE

[Arts, Science & Commerce]

NAAC Re-Accreditation "A" Grade

"BEST COLLEGE" University of Mumbai

Autonomous College

(Affiliated to Mumbai University)

SYLLABUS FOR SEM - I & II

Program: B.Sc. Physics

Course Code: RJSUPHY

Credit Based Semester System w. e. f. the Academic Year 2021 – 2022

Draft Syllabus for F.Y.B.Sc. Physics (Theory & Practical)
(Choice Based Credit System w. e. f. academic year 2021-22)

The revised syllabus in Physics as per credit based system for the First Year B.Sc. Course will be implemented from the academic year 2021–2022.

Preamble:
The systematic and planned curricula from these courses shall motivate and encourage learners to understand basic concepts of Physics.

Program outcomes:
• 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
	Semester I
RJSUPHY101	**Classical Mechanics**
RJSUPHY102	**Modern Physics**
RJSUPHY1P01	**Practical I**
	Semester II
RJSUPHY201	**Thermodynamics**
RJSUPHY202	**Electricity and Electrostatics**
RJSUPHY2P01	**Practical II**

SEMESTER-I

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	I	Physics
Course Code	**Title**		
RJSUPHY101	Classical Mechanics		

SEMESTER I
Physics Paper 1 (Classical Mechanics)

Course Outcomes:

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

1. The concept of vectors, force and their significance.
2. Understand Newton's laws and apply them in calculations of the motion of simple systems.
3. Use the free body diagrams to analyze the forces on the object.
4. Understand the concepts of friction and the concepts of elasticity and be able to perform calculations using them.

Unit I **15 lectures**

1. **Vectors and Vector Addition, Components of Vectors, Dot and Cross Product.**
   UP: 1.7, 1.8
2. **Force and Interaction, Superposition of forces, Newton's First law, Inertial frame of reference, Newton's second law, Mass and force, Mass and weight, Newton's third law, Free body diagram.**
   UP: 4.1-4.6
3. **Application of Newton's first law: Equilibrium of a particle examples, Using Newton's second law: Dynamics of particles, examples, Apparent weight and weightlessness, Friction Forces, Kinetic and Static friction, Fluid resistance and terminal speed.**
   UP: 5.1-5.3

Learning Outcomes: Students learn

1. The difference between scalars and vectors, and how to add and subtract vectors graphically.
2. How to calculate the product of two vectors and the components of a vector.
3. Use the vectors in calculations.
4. Understand Newton's laws and apply them in calculations of the motion of simple systems.

Unit II **15 lectures**

1. **Work: Positive, negative, zero and total work. Kinetic energy and work energy theorem problems, Work and KE in composite system. Work and energy with varying forces. Power**
   UP: 6.1-6.4,
2. **Gravitational potential energy and its conservation examples, Conservative and non-conservative forces (7.3) Force and potential energy, Energy diagram.**
   UP: 7.1-7.5

Learning Outcomes: The students learn

1. What the concept of force means in physics, and why forces are vectors.
2. The significance of the net force on an object, and what happens when the net force is zero.
3. The relationship among the net force on an object, the object's mass, and its acceleration.
4. How the forces, the two bodies exert on each other are related.

5. To get acquainted to use the free body diagrams to analyze the forces on the object.

Unit III **15 lectures**

1. **Equilibrium and Elasticity: Conditions for equilibrium. Stress strain and elastic moduli, Tensile and compressive stress and strain, Bulk stress and strain, Shear stress and strain, Stress versus strain curve**
   UP: 11.1, 11.5
2. **Fluid Mechanics: 12.1-12.3(review), Fluid flow, The continuity equation, Bernoulli's theorem. Viscosity and Turbulence**
   UP: 12.4- to12.6

Learning Outcomes: The students learn to apply

1. Newton's first law to solve problems involving the forces that act on a body in equilibrium.
2. Newton's second law to solve problems involving the forces that act on an accelerating body.
3. Their knowledge in distinguishing the different types of friction forces, e.g. static friction, kinetic friction, rolling friction, and fluid resistance.
4. Their knowledge to solve problems that involve these forces.

Note: A good number of numerical examples are expected to be covered (few of them may be related to other streams of science like biology) during the prescribed lectures.

References:

1. **Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman (2015, Pearson Education, 14th edition)**

Additional References:

1. H. C. Verma, Concepts of Physics – (Part–I), 2002 Ed. Bharati Bhavan Publishers.

2. Murray R Spiegel, Schaum's outline of Theory and problems of Vector Analysis, Asian students Edition

SEMESTER-I

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	I	Physics
Course Code	**Title**		
RJSUPHY102	**Modern Physics**		

Physics paper II (Modern Physics)

Course Outcomes:

After successful completion of this course students will be able to

1. Understand nuclear properties and nuclear behavior.
2. Understand the type isotopes and their applications.
3. Demonstrate and understand the quantum mechanical concepts.
4. Demonstrate quantitative problem solving skills in all the topics covered.

Unit I **15 lectures**

1. Properties of Nuclei, Nuclear Density, Nuclides and Isotopes, Nuclear Spins and Magnetic Moments, Nuclear Magnetic Resonance and MRI. Nuclear Binding and Nuclear Structure, The Nuclear Force, The Liquid-Drop Model, The Shell Model. Nuclear Stability and Radioactivity, Alpha Decay, Beta Decay, Gamma Decay, Radioactive Decay Series. Activities and Half-Lives, Radioactive Decay Rates Radioactive Dating, Radiation in the Home. Biological Effects of Radiation, Calculating Radiation Doses, Radiation Hazards, Beneficial Uses of Radiation.
UP: 43.1, 43.2, 43.3, 43.4, 43.5

Learning Outcomes:

1. Students will learn some key properties of atomic nuclei, including radii, densities, spins, and magnetic moments.
2. They will understand how the binding energy of a nucleus depends on the numbers of protons and neutrons that it contains.
3. They will also know about the most important ways in which unstable nuclei undergo radioactive decay.
4. They will be able to calculate how the decay rate of a radioactive substance depends on time.
5. They will be acquainted with some of the biological hazards and medical uses of radiation.

Unit II **15 lectures**

Nuclear Reactions, Reaction Energy, Neutron Absorption. Nuclear Fission, Fission Reactions, Liquid Drop Model, Chain Reactions, Nuclear Reactors. Nuclear Fusion, Fundamental Particles—A History, The Electron and the Proton, The Photon, The Neutron, The Positron, Particles as Force Mediators, Mesons. Particles and Interactions.
UP: 43.6, 43.7, 43.8, 44.1, 44.3

Learning Outcomes:

1. Students will learn how to analyze some important types of nuclear reactions.
2. They will also understand what happens in a nuclear fission chain reaction, and how it can be controlled.
3. They will find out about the nuclear reactions that allow the sun to shine.
4. They will be introduced to the key varieties of fundamental subatomic particles and how they were discovered.
5. They will also get to know the four ways in which subatomic particles interact with each other.

Unit III **15 lectures**

Light Absorbed as Photons: The Photoelectric Effect, Light Emitted as Photons: X-Ray Production, Light Scattered as Photons: Compton Scattering and Pair Production Wave–Particle Duality, Probability, and Uncertainty, X-Ray Diffraction, Electron Waves, The Nuclear Atom and Atomic Spectra, The Laser, Continuous Spectra, The Uncertainty Principle Revisited
UP: 38.1, 38.2, 38.3, 38.4, 36.6, 39.1, 39.2, 39.4, 39.5, 39.6

Learning Outcomes:

1. Students will, through various experiments, learn the photon picture of light.

2. They will understand how the Heisenberg uncertainty principle imposes fundamental limits on what can be measured.
3. They will also learn about the wave particle duality and its experimental evidence.
4. They will further learn how physicists discovered the atomic nucleus and the working of a Laser.
5. They will understand how the spectra of light originate.

Note: A good number of numerical examples are expected to be covered (few of them may be related to other streams of science like biology) during the prescribed lectures.

References: Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman (2015, Pearson Education, 14th edition)

Additional References:
S N Ghosal, Atomic Physics, S Chand

SEMESTER-I

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	I	Physics
Course Code	**Title**		
RJSUPHY1P01	Practical I		

Leaning 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 and their use without fear.
iv) To correlate their physics theory concepts through practical.
v) Understand the concepts of errors and their estimation.

A. Regular Experiment:
1) Torsional Oscillation: To determine modulus of rigidity η of a material of wire by Torsional oscillations
2) Bifilar Pendulum
3) Y by vibrations: To determine Young's Modulus of a material by method of vibrations- [wooden scale]
4) Flat spiral spring: Measurement of Young's modulus
5) To determine Coefficient of Viscosity (η) of a given liquid by Poisseuli's Method. (check on simulator)
6) Surface Tension/ Angle of contact.
7) R.I. of liquid using LASER.
8) Y by bending.
9) Verification of Stokes theorem.
10) Flywheel: To determine MI and Frictional Torque of Flywheel.
11) Jaegers' method to find Surface tension.
12) Helmholtz Resonator: To find unknown frequency of tuning fork.
13) J by Electrical Method: To determine mechanical equivalent of heat.

B. Skill Experiments:
1. Use of vernier calipers, Micrometer Screw Gauge, Travelling Microscope.
2. Graph Plotting: Experimental, Straight Line with intercept, Resonance Curve etc.
3. Use of DMM and Scientific calculator.

4. Absolute and relative errors calculation.

Note:

1. Any new experiment relevant to syllabus may be added at any time.
2. The skill experiments listed in the above list are required to be performed as a part of laboratory orientation.
3. Minimum **8** experiments from the list of the Regular experiments should be completed and reported in the journal, in the first semester.
4. **Certified Journal is a must,** to be eligible to appear for the semester end practical examination.

Scheme of Examination:

A candidate will be allowed to appear for the semester end practical examination, only if the candidate submits a Certified Journal, at the time of practical examination of the semester or a certificate from the Head of the Department /Institute, to the effect that the candidate has completed the practical course of that semester of F.Y.B.Sc. Physics , as per the minimum requirement. The duration of the practical examination will be of two hours per experiment. There will be two experiments through which the candidate will be examined in the practical examination. The questions on the slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of Physics.

SEMESTER-II

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	II	Physics
Course Code	**Title**		
RJSUPHY201	**Thermodynamics**		

Course Outcomes:

On successful completion of this course students will be able to:
Understand how the interactions between the molecules of a substance determine the properties of the substance .
Apply the laws of thermodynamics to formulate the relations necessary to analyze at thermodynamic process.
Learn the concepts of internal energy and temperature of the molecules of gas.
Demonstrate quantitative problem solving skills in all the topics covered

SEMESTER II
Physics Paper I (Thermodynamics)

Unit I **15 lectures**

1.Temperature, heat & thermal properties of matter.
Review of thermometers, Temperature scale, Kalvin scale and absolute temperature.
Temperature and thermal equilibrium, Thermal expansion, quantity of heat, calorimetry and phase changes, mechanism of heat Transfer, Numerical examples
UP: 17.1, 17.4, 17.5, 17.6, 17.7
2.Review of Kinetic-Molecular model of an ideal gas,
Equations of state, Heat capacities, Molecular speeds, phases of matter. Numerical examples
UP:18.1, 18.4, 18.5

Learning outcomes:

1. The students learn the physics behind the absolute or Kelvin temperature scale and thermal equilibrium.
2. They understand the meaning of heat, and how it differs from temperature.
3. They learn how to do calculations that involve heat flow, temperature changes, and changes of phase.
4. They learn the concept of heat transfer e. g. conduction, convection, and radiation.
5. They understand the relation between the pressure, volume, and temperature with kinetic energy of the molecules of the gas.

Unit II **15 lectures**

1.The First Law of Thermodynamics

Thermodynamic systems, Work done during volume changes, paths between Thermodynamic states, Internal energy and the First law of Thermodynamics.

2. Thermodynamic processes, Internal energy of an ideal gas, Heat capacities of an Ideal gas, Adiabatic processes for an ideal gas, numerical.

UP: 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8

Learning outcomes: The students learn

1. The significance of thermodynamic systems and processes.
2. How to calculate work done by a system when its volume changes.
3. To interpret and use the first law of thermodynamics.
4. Four important kinds of thermodynamic processes.
5. Why the internal energy of an ideal gas depends on temperature only.
6. The difference between molar heat capacities at constant volume and at constant pressure and how to analyse adiabatic processes in an ideal gas.

Unit III **15 lectures**

1. The Second Law of Thermodynamics

Directions of thermodynamic processes, Heat engines, internal-combustion engines, Refrigerators, the second

2. Law of thermodynamics, the Carnot cycle, entropy, microscopic interpretation of entropy, numerical.

UP: 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8

Learning outcomes: The students learn

1. The difference between reversible and irreversible processes.
2. What a heat engine is, and how to calculate its efficiency.
3. The physics of internal-combustion engines, how refrigerators and heat engines are related, and how to analyze the performance of a refrigerator.
4. How the second law of thermodynamics sets limits on the efficiency of engines and the performance of refrigerators.
5. How to solve problems involving the idealized Carnot cycle for engines and refrigerators.
6. What is meant by entropy, and how to use this concept to analyze thermodynamic processes.

Note: A good number of numerical examples are expected to be covered (few of them may be related to other streams of science like biology) during the prescribed lectures.

References:

1. **Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman (2015, Pearson Education, 14th edition)**

Additional References:

1. M W Zemansky and R H Dittman, Heat and Thermodynamics, McGraw Hill.

SEMESTER-II

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	II	Physics
Course Code	**Title**		
RJSUPHY202	Electricity and Electrostatics		

Course Outcomes: After the successful completion of the course students will be able to:

Understand nature of electric charge, their conservation and Coulomb's law to calculate the electric force between charges.

The distinction between electric force and electric field and how to use the idea of electric field lines to visualize and interpret electric fields.

How to calculate the electric potential energy of a collection of charges and using them to calculate the electric field.

Understand the dc circuits having multiple components e.g. resistors, capacitors and inductors.

Understand the force on a moving charged particle in a magnetic field its practical applications in chemistry and physics.

How to analyse and calculate magnetic forces on current-carrying conductors.

Physics Paper II (Electricity and Electrostatics)

Unit I **15 lectures**

1. **Electric charge and Electric field: Electric charge, Conductors, Insulators and Induced charges , Coulomb's law and examples, Electric field and Electric forces, Electric field lines**
2. **Electric potential: Electric potential and examples, Equipotential surfaces, Potential gradient**

UP: 21.1, 21.2, 21.3, 21.4, 21.6, 23.2, 23.4, 23.5

Learning Outcomes:

1. The students learn the nature of electric charge, and how the electric charge is conserved.
2. They also know how objects become electrically charged.
3. They understand how to apply Coulomb's law to calculate the electric force between charges.
4. They can distinguish between electric force and electric field.
5. They learn how to calculate the electric field due to a collection of charges.
6. They get acquainted with the idea of electric field lines to visualize and interpret electric fields.
7. They also know how to calculate the electric potential energy of a collection of charges, equipotential surfaces and they are able to visualize the variation of electric potential in space.

Unit II **15 lectures**

1. **Capacitance and Dielectrics: Capacitor and capacitance, Capacitor in series and parallel, Energy stored in Capacitor and electric-field energy, Dielectrics**
2. **Current, Resistance and Electromotive Force: Current, Resistivity, Resistance, Electromotive force and Circuits.**

UP: 24.1, 24.2, 24.3, 24.4. 25.1, 25.2, 25.3, 25.4

Learning Outcomes:

1. The students learn the nature of capacitors, and how to calculate a quantity that measures their ability to store charge.
2. They understand how to analyse capacitors connected in a network and how to calculate the amount of energy stored in a capacitor.
3. They get acquainted with the concept of dielectrics, and how they make capacitors more effective.
4. They understand the meaning of electric current, and how charges move in a conductor.
5. They learn the meaning of the resistivity and conductivity of a substance and how to calculate the resistance of a conductor from its dimensions and its resistivity.
6. They learn how an electromotive force (emf) makes it possible for current to flow in a circuit.

Unit III **15 lectures**

1. **Direct-current circuits: Resistor in series and parallel, Kirchoff's rule, R-C circuits, Power distribution system**
2. **Inductance: Mutual inductance, Self-inductance and Inductors, Inductors and magnetic field energy, The R-L circuits, The L-C circuits.**

UP: 26.1, 26.2, 26.4, 26.5, 30.1, 30.2, 30.3, 30.4, 30.5

Learning Outcomes:

1. The students learn how to analyse circuits with multiple resistors in series or parallel.
2. They get acquainted with the rules that one can apply to any circuit with more than one loop.
3. They know how to analyse circuits that include both a resistor and a capacitor.
4. They understand how a time-varying current in one coil can induce an emf in a second, unconnected coil and how to relate the induced emf in a circuit to the rate of change of current in the same circuit.
5. They know how to calculate the energy stored in a magnetic field and why electrical oscillations occur in circuits that include both an inductor and a capacitor.

Note: A good number of numerical examples are expected to be covered (few of them may be related to other streams of science like biology) during the prescribed lectures.

References:

1. **Sears and Zemansky's University Physics with Modern Physics, Hugh D. Young and Roger A. Freedman (2015, Pearson Education, 14th edition)**

Additional reference:

1. **David J. Griffiths, Introduction to Electrodynamics.**
2. **H. C. Verma, Concepts of Physics.**

SEMESTER-II

Name of the Program	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	II	Physics
Course Code	**Title**		
RJSUPHY2P01	Practical II		

Leaning Outcome:

i) To understand and practice the skills while doing physics practical.

ii) To understand the use of apparatus and their use without fear.

iii) To correlate their physics theory concepts through practical.

iv)Understand the concepts of errors and their estimation.

A) Physics Practical List.

1) To study Thermistor Characteristic Resistance Vs. Temperature.
2) Constant volume/constant pressure.
3) LDR Characteristics: To study the dependence of LDR resistance on intensity of light
4) RL Circuit: Transient To determine the value of given inductance and phase angle
5) RC Circuit: Transient To determine value of given capacitor and Phase angle
6) Thevenin's Theorem: To verify Thevenin's theorem for DC circuits
7) Norton's Theorem: To verify Norton's Theorem for DC circuits
8) Maximum Power transfer theorem
10) To find equi-potential surface
11) EMF generated in tangent galvanometer
12) Photoelectric effect: to measure Planck's constant
13) Capacitor: Dielectric constant measurement

Note:

1. Any new experiment relevant to syllabus may be added at any time.
2. The skill experiments listed in the above list are required to be performed as a part of laboratory orientation.
3. Minimum **8** experiments from the list of the Regular experiments should be completed and reported in the journal, in the first semester.
4. **Certified Journal is a must,** to be eligible to appear for the semester end practical examination.

B) List of Demo-experiments:

1. Newton's Ring.
2. Light dependent switch.
3. Laser beam divergence, Intensity.
4. Use of Oscilloscope.
5. Charging and discharging of a capacitor.
6. Single slit diffraction.
7. Show ripple with & without filter (Using CRO) in a bridge rectifier.
8. Magnetization Exp. (Mapping and Magnetic lines)
9. Faraday's laws.

Note:

The demo experiments listed in the above list will be demonstrated to the students. Minimum **8** experiments from the list of the Regular experiments should be completed and reported in the journal, in the second semester. **Certified Journal is a must,** to be eligible to appear for the semester end practical examination.

Scheme of Examination:

A candidate will be allowed to appear for the semester end practical examination, only if the candidate submits a Certified Journal, at the time of practical examination of the semester or a certificate from the Head of the Department /Institute, to the effect that the candidate has completed the practical course of that semester of F.Y.B.Sc. Physics, as per the minimum requirement. The duration of the practical examination will be of two hours per experiment. There

will be two experiments through which the candidate will be examined in the practical examination. The questions on the slips for the same should be framed in such a way that candidate will be able to complete the task and should be evaluated for its skill and understanding of Physics.