St. Xavier's College – Autonomous
Mumbai

Syllabus
For 1st Semester Courses in PHYSICS
(Academic Year 2016 - 2017 onwards)

Contents:

F.Y. B.Sc. PHYSICS Course: S.PHY.1.01

Title: Mechanics

Learning Objectives:
To study the fundamentals of Mechanics
Number of lectures: 45

Unit 1. Force, Work and Energy (15 lecture)

NEWTON'S LAWS OF MOTION
Force and Interactions, Newton's First Law, Newton's Second Law , Mass and Weight, Newton's Third Law , Free-Body Diagrams Questions/Exercises/Problems

APPLYING NEWTON'S LAWS
Using Newton's First Law: Particles in Equilibrium, Using Newton's Second Law: Dynamics of Particles, Frictional Forces, Dynamics of Circular Motion, The Fundamental Forces of Nature, Questions/Exercises/Problems

WORK AND KINETIC ENERGY
Work, Kinetic Energy and the Work–Energy Theorem, Work and Energy with Varying Forces, Power Questions/Exercises/Problems

Unit 2. Potential energy, Momentum and Rotation (15 lecture)

POTENTIAL ENERGY AND ENERGY CONSERVATION
Gravitational Potential Energy, Elastic Potential Energy, Conservative and Non conservative Forces , Force and Potential Energy, Energy Diagrams Questions/Exercises/Problems

MOMENTUM, IMPULSE, AND COLLISIONS
Momentum and Impulse, Conservation of Momentum, Momentum Conservation and Collisions, Elastic Collisions, Center of Mass, Rocket Propulsion Questions/Exercises/Problems

ROTATION OF RIGID BODIES
Angular Velocity and Acceleration, Rotation with Constant Angular Acceleration, Relating Linear and Angular Kinematics, Energy in Rotational Motion, Parallel-Axis Theorem, Moment-of-Inertia Calculations, Questions/Exercises/Problems

Unit 3. Rotation, Fluids and Gravitation (15 lecture)

DYNAMICS OF ROTATIONAL MOTION
Torque, Torque and Angular Acceleration for a Rigid Body Rigid-Body Rotation About a Moving Axis Work and Power in Rotational Motion, Angular Momentum, Conservation of Angular Momentum, Gyroscopes and Precession, Questions/Exercises/Problems

FLUID MECHANICS
Density, Pressure in a Fluid, Buoyancy, Fluid Flow, Bernoulli's Equation, Viscosity and Turbulence, Questions/Exercises/Problems

GRAVITATION
Newton's Law of Gravitation, Weight, Gravitational Potential Energy, The Motion of Satellites, Kepler's Laws and the Motion of Planets, Spherical Mass Distributions, Apparent Weight and the Earth's Rotation, Black Holes, Questions/Exercises/Problems

Reference University Physics, Sears &Zemansky, Young and Freedman, Pearson
Fundamentals of Physics, Halliday and Resnick

F.Y. B.Sc. PHYSICS Course: S.PHY.1.02

Title: Waves and Thermodynamics

Learning Objectives:

To study the fundamentals of Waves and thermodynamics

Number of lectures: 45

Unit 1. Oscillations and waves (15 lecture)

Equilibrium and elasticity: Conditions for Equilibrium, Centre of Gravity, Solving Rigid-Body Equilibrium Problems, Stress, Strain, and Elastic Moduli Elasticity and Plasticity, Questions/Exercises/Problems

Periodic motion: Describing Oscillation, Simple Harmonic Motion, Energy in Simple Harmonic Motion Applications of Simple Harmonic Motion, the Simple Pendulum, the Physical Pendulum, Damped Oscillations, Forced Oscillations and Resonance Questions/Exercises/Problems

Mechanical waves: Types of Mechanical Waves, Periodic Waves, Mathematical Description of a Wave, Speed of a Transverse Wave, Energy in Wave Motion, Wave Interference, Boundary Conditions, and Superposition, Standing Waves on a String, Normal Modes of a String. Questions/Exercises/Problems

Unit 2. Sound and Thermodynamics (15 lecture)

Sound and hearing : Sound Waves, Speed of Sound Waves, Sound Intensity, Standing Sound Waves and Normal Modes, Resonance and Sound Interference of Waves , Beats, The Doppler Effect , Shock Waves, Questions/Exercises/Problems

Temperature and heat: Temperature and Thermal Equilibrium, Thermometers and Temperature Scales, Gas Thermometers and the Kelvin Scale, Thermal Expansion, Quantity of Heat, Calorimetry and Phase Changes, Mechanisms of Heat Transfer. Questions/Exercises/Problems

Thermal properties of matter: Equations of State , Molecular Properties of Matter, Kinetic-Molecular Model of an Ideal Gas, Heat Capacities, Molecular Speeds ,Phases of Matter Summary Questions/Exercises/Problems

Unit 3. Laws of thermodynamics (15 lecture)

The first law of thermodynamics: Thermodynamic Systems ,Work Done During Volume Changes , Paths Between Thermodynamic States , Internal Energy and the First Law of Thermodynamics, Kinds of Thermodynamic Processes, Internal Energy of an Ideal Gas , Heat Capacities of an Ideal Gas, Adiabatic Processes for an Ideal Gas Questions/Exercises/Problems

The second law of thermodynamics: Directions of Thermodynamic Processes, Heat Engines, Internal-Combustion Engines, Refrigerators, The Second Law of Thermodynamics, The Carnot Cycle, Entropy, Microscopic Interpretation of Entropy, Questions/Exercises/Problems

References:

University Physics, Sears & Zemansky, Young and Freedman, Pearson

Fundamentals of Physics, Halliday and Resnick

Practical Course: S.PHY.1.PR F.Y.B.Sc Physics

In the First Semester each batch of students will come to Physics lab for 8 weeks (excluding all the holidays) that is 16 lab sessions of 2 and half hour each. Out of these we plan to utilize 4 lab sessions (8 periods of 50 min each or 10hrs) to train them for learning Physics through Scientific Inquiry.

Objectives:

1. Understanding of the concepts of knowledge and inquiry
2. Ability for rational inquiry
3. Mindset for Rational Temper

Understanding of the concepts of knowledge and inquiry,

In these sessions student would learn,

- Appreciation for knowledge and its justification,
- Concepts of rational vs. irrational and subjective vs. objective inquiry,
- Types of reasoning, predictions/conjectures, theoretical frameworks, laws, and models, Observational inquiry and inquiry

Ability for rational inquiry

In these sessions student would enhance their ability to,

- Careful, systematic and relevant observations and making observational reports,
- Design and conduct experiments,
- Notice and formulate patterns in observations and experiments,
- Establish observational generalizations based patterns,
- Explore and establish the causal factors of observational generalizations, with an awareness of the distinction between causes and correlations,
- Explain the generalizations in (4) and (5) either within an existing theory, or by creating a novel theory.
- Think through concepts and ideas, clarify and define them, and evaluate the definitions;
- Unearth, explicitly articulate, and critically evaluate hidden assumptions and biases.
- Create abstract entities and processes, with clear and precise definitions
- Set up imaginary worlds in which these entities exist by formulating axioms that govern them.
- Notice the patterns in (12) and formulate them as conjectures.
- Reason in a wide range of domains, using appropriate modes of reasoning.
- Identify logical consequences and detect logical contradictions, if any.
- Prove and refute (justify, with evidence and arguments).
- Participate in rational debates without the desire to win and the fear of 'loss of face' when one is proved wrong,
- Ability to make connections across diverse domains, notice similarities and differences and at the same time apprehend the unity underlying diversity, and to integrate what is otherwise fragmented.

Mindset for Rational Temper

- Intellectual curiosity: the desire to find out about things
- The joy of learning and of finding things out on one's own
- Openness to criticism: the predisposition to accept and seek criticism in the spirit of self-correction

- Intellectual scepticism: the habit of doubting and questioning the values, norms, beliefs, and practices of authorities and peers, as well as one's own; unwillingness to accept assertions unless supported by adequate reasons
- Open-mindedness: willingness to modify one's beliefs and practices when confronted with good reasons to do so
- Commitment to the epistemic values of truth, rationality, and rigour, and to clarity and precision of thought and expression;
- Commitment to the ethical values of truthfulness and integrity; and
- Commitment to the well-being of the earth and all its creatures, and the avoidance of harm
- Readiness to pursue what is demanded by the above commitments
- Sequencing Problem

Reading and viewing

- Einstein, A & L, Infeld (1935) *The Evolution of Physics* , downloadable at https://archive.org/details/evolutionofphysi033254mbp
- Videos of Feynman on youtube (e.g., The Pleasure of Finding things Out)
- Mohanan, K P and T Mohanan (2015) "Region of Inexactness and related concepts
- Mohanan K P & T Mohanan (2015) Observational Inquiry

Rest of the experiments will be selected from the following list and will be conducted with skills obtained in above sessions

List of Experiments:

Paper 1:

1. Measurement Length, Mass, Time
2. Measuring Tension/breaking tension
3. Measurement of angle
4. Measurement of angular velocity/angular momentum
5. 'Y' by bending
6. 'Y' by Searls method
7. Bifillar suspension
8. Determination of gravitational acceleration
9. Fly wheel

Paper2:

1. Simple pendulum
2. Bar pendulum with resonance
3. Lee's method
4. Capillary rise
5. Surface tension – drop method
6. Use of manometer
7. CVAT
8. Determination of density of different liquids
9. Pascal's law
10. Beats
11. Different Thermometers
12. Measuring body temperature with various scales
13. Change of boiling point of water with pressure.