SOPHIA COLLEGE (AUTONUMOS)

Affiliated to

University of Mumbai

Faculty of Science

Syllabus for F.Y.B.Sc

Semester I and II

Program: B.Sc.

Course: PHYSICS

(As per the Choice Based Credit System, to be implemented with effect from the academic year 2022 – 2023)

F.Y.B.Sc. PHYSICS Syllabus (General Outline) Revised for Autonomy

To be implemented from the Academic Year 2022 - 2023.

F.Y.B. Sc.				
Theory (Semester 1 and 2)				
Paper No	**Course Code**	**Title of Paper**	**Credits**	**Status**
I	SBSPHY101	Classical Physics	2	Unchanged
II	SBSPHY102	Modern Physics	2	Unchanged
I	SBSPHY201	Mathematical Physics, Electrical & Electronics	2	Revised
II	SBSPHY202	Electricity and Electronics	2	Revised
Practical (Semester 1 and 2)				
Paper I	SBSPHYP1	Practical I	2	Unchanged
Paper II	SBSPHYP2	Practical II	2	Unchanged

Physics (Syllabus)

SEMESTER I

SBSPHY101 Classical Mechanics and Optics

Course Objective

1. Provide in-depth knowledge of mechanical systems, conservation laws involving energy, momentum, etc.
2. To study the elastic behavior and fluid mechanics
3. To learn the theory and experiment of interference
4. To analyze the Zeroth law of thermodynamics and entropy

Course Outcomes:

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

1. Understand Newton's laws and apply them in calculations of the motion of simple systems.

2. Use the free body diagrams to analyze the forces on the object.

3. Understand the concepts of friction and the concepts of elasticity, and fluid mechanics and be able to perform calculations using them.

4. Understand the concepts of lens system and interference.

5. Apply the laws of thermodynamics to formulate the relations necessary to analyze a thermodynamic process.

Unit: I **15 lectures**

1. Newton’s Laws:

Newton’s first, second, and third laws of motion, problem-based on Newton’s law, pseudo forces, Inertial frame of reference and utility of the idea of pseudo force, Introduction to frictional & normal forces, Worked out examples (with friction present)

2. Elasticity: Review of Elastic constants Y, K, η, and σ; Equivalence of shear strain to compression and extension strains. Relations between elastic constants, Couple for a twist in the cylinder.

3. Fluid Dynamics:

Equation of continuity, Bernoulli's equation, applications of Bernoulli's equation, streamline and turbulent flow, lines of flow in an airfoil, Poiseuille's equation, Significance in Human blood circulatory system.

Unit: II **15 lectures**

1. Lens Maker's Formula (Review), Newton's lens equation, magnification -lateral, longitudinal, and angular.

2. Equivalent focal length of two thin lenses, thick lens (introduction/concept), Ramsden and Huygens eyepiece.

3. Aberration: Spherical Aberration, Reduction of Spherical Aberration, Chromatic aberration, and condition for achromatic aberration.

3. Interference: Interference in thin films, Fringes in Wedge shaped films, Newton's Rings (Reflective).

UNIT III **15 lectures**

1. Behavior of real gases and real gas equation, Van der Waal equation

2. Thermodynamic Systems, zeroth law of thermodynamics, Concept of Heat, the first law, Isochoric, Isobaric, Isothermal, Adiabatic process, Work and Heat as path functions, Internal energy, Heat Capacity, and specific heat, Applications of first law to simple processes, general relations from the first law, Indicator diagrams.

Note: A good number of numerical examples are expected to be covered during the prescribed lectures

References:

1. Halliday, Resnick and Walker, Fundamental of Physics (extended) – (6th Ed.), John Wiley and Sons. https://www.wiley.com/enus/Fundamentals+of+Physics%2C+Extended%2C+11th+Edition-p-9781119306856 (E – Book)
2. H. C. Verma, Concepts of Physics – (Part–I), 2002 Ed. Bharati Bhavan Publishers.

https://bookwindow.in/product.php/concepts-of-physics-i-h-c-verma
(Kindle Edition)

3. Brijlal, Subramanyam and Avadhanulu a Textbook of Optics, 25th revised ed. (2012) S. Chand
https://www.ebooknetworking.net/ebooks/optics-by-n-subramaniam.html
4. Brijlal, Subramanyam and Hemne, Heat Thermodynamics and Statistical Physics, S Chand, Revised, Multi- coloured, 2007 Ed.
https://www.google.co.in/books/edition/Heat_Thermodynamics_and_Statistical_Phys/0zP8wAEACAAJ?hl=en&gbpv=0
5. Jenkins and White, Fundamentals of Optics by (4th Ed.), McGraw Hill International.
6. Guyton and Hall, Textbook of Medical Physiology, Second South Asia Edition, Elsevier.
https://www.amazon.in/Guyton-Textbook-Medical-Physiology-3rd-book-ebook-dp-B08F2P3BDV/dp/B08F2P3BDV/ref=dp_ob_title_def (Kindle Edition)

Additional References:

1. Thornton and Marion, Classical Dynamics – (5th Ed)
2. D S Mathur, Element of Properties of Matter, S Chand & Co.
3. R Murugeshan and K Shivprasath, Properties of Matter and Acoustics Chand.
4. M W Zemansky and R H Dittman, Heat and Thermodynamics, McGraw Hill. (5^{th} edition)
5. D K Chakrabarti, Theory and Experiments on Thermal Physics, (2006 Ed) Central books.
6. C L Arora, Optics, S Chand, 1999
7. Hans and Puri, Mechanics –, 2nd Ed. Tata McGraw Hill (Move up in references)

SEMESTER - I

SBSPHY102 Modern Physics

Course Objective:

1. To learn and explore the concepts of fundamentals of nuclear and particle physics
2. Learn the properties of X – Rays, verify Bragg's equation, Compton effect
3. Recognizing the relation between particle and matter, analyze the idea of nucleus and their energy, nuclear fission and fusion.

Course Outcomes:

After successful completion of this course, students will be able to

1. Understand nuclear properties, nuclear behavior, type of isotopes, and their applications.
2. Understand and analyze the fundamental building blocks of matter and radiation, interaction among elementary particles, and their behavior.
3. Understand the applications of X – Rays diffraction in crystals, and apply quantum mechanical concepts.

Unit I **15 lectures**

1. Structure of Nuclei: Basic properties of nuclei, Composition, Charge, Size, Rutherford's experiment for estimation of nuclear size, the density of nucleus, Mass defect and Binding energy, Packing fraction, BE/A vs A plot, and stability of nuclei (N vs Z plot).

2. Radioactivity: Radioactive disintegration concept of natural and artificial Radioactivity, Properties of α, β, γ-rays, laws of radioactive decay, half-life, mean life (derivation not required), units of radioactivity, successive disintegration and equilibriums, radioisotopes, Carbon dating, and other applications of radioactive isotope's applications of Isotopes in Medicine, Industry, etc.

Unit II **15 lectures**

Interaction between particles and matter, Ionization chamber, Proportional counter and GM counter, Scintillation counter, Liquid Scintillation counter, Crystal counter.

Interaction of Gamma rays with Matter, Photoelectric effect, Compton effect, pair production, Attenuation and Absorption Coefficients, Radiation Units-Unit of Exposure: KERMA (Kinetic Energy release to Matter), Absorbed Dose and Derived Units- Equivalent Dose and Effective Dose.

Nuclear Reactions: Types of Reactions and Conservation Laws, Concept of Compound and Direct Reaction, Q - value equation and solution of the Q equation, problems.

Fusion and fission definitions and qualitative discussion with examples.

Unit III **15 lectures**

1. Origin of Quantum theory, Black body (definition), Black Body spectrum, Wien's displacement law, Matter waves, wave-particle duality, Heisenberg's uncertainty principle. Davisson - Germer experiment, G. P. Thompson experiment.

2. X-Rays production and properties. Continuous and characteristic X-Ray spectra, X-Ray Diffraction, Bragg's Law, Applications of X-Rays.

3. **Interaction of radiation with living system:**

Review:(Water, structure of water) Radiolytic products of water, radical reactions in the biological system. Direct and indirect effect on living system (cell/Biomolecules). Mechanism of direct and indirect action of radiation, induction radiation induced damage at cellular level.

Note: A good number of numerical examples are expected to be covered during the prescribed lectures

References:

1. Kaplan: Nuclear Physics, Irving Kaplan, 2nd Ed. Narosa Publishing House http://www.fulviofrisone.com/attachments/article/355/Kaplan,+Nuclear+physics[1].pdf

2. Dr. S. B. Patel, Nuclear Physics Reprint 2009, New Age International
3. N Subrahmanyam, Brijlal and Seshan, Atomic and Nuclear Physics Revised Ed. Reprint 2012, S. Chand
4. Arthur Beiser, Perspectives of Modern Physics: Tata McGraw Hill

Additional References:

1. S N Ghosal, Atomic Physics S Chand
2. S N Ghosal, Nuclear Physics 2nd ed. S Chand
3. Nuclear and Particle Physics, B. R. Martin # 2006 John Wiley & Sons, Ltd. ISBN: 0-470-01999-9

https://qa.ff.up.pt/rq2020/Bibliografia/Books/Martin%20-%20Nuclear%20and%20Particle%20Physics%20-%20An%20Introduction.pdf

SEMESTER - I

SBSPHYP1 Practical 1

A. **Regular experiments**:

1. J by Electrical Method: To determine mechanical equivalent of (Radiation correction by graph method)

2. Torsional Oscillation: To determine modulus of rigidity η of a material of wire by torsional oscillations/Biological Fibre.

3. Bifilar Pendulum: To determine moment of inertia of a bifilar pendulum

4. Flywheel: To determine moment of inertia of flywheel

5. Spectrometer: To determine of angle of Prism.

6. Y by vibrations: To determine Y Young's Modulus of a wire material by method of vibrations- Flat spiral spring.

7. To determine Coefficient of Viscosity (η) of a given liquid by Poisseuli's Method/ Biological Fluid

8. Surface Tension/ Angle of contact (Biological Fluid)

9. Combination of Lenses to determine the equivalent focal length of a lens system by magnification method.

10. Spectrometer: To determine the refractive index μ of the material of the prism

11. To study Thermistor characteristic Resistance vs Temperature

12. Constant volume/constant pressure

13. Newton's Rings: To determine the radius of curvature of a given convex lens using Newton's rings.

14. Wedge Shaped Film: To determination of the thickness of wire by obtaining fringes in wedge shaped air film.

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. Spectrometer: Schuster's Method

4. Use of DMM

5 Absolute and relative errors calculation

C) Any one out of following is equivalent to two experiments from section A and/ or B

1. Students should collect the information of at least five Physicists with their work. Report that in journal.

2. Students should carry out mini-project upto the satisfaction of professor In-charge of practical.

3. Study tour Students participated in study tour must submit a study tour report.

Minimum 8 experiments from the list should be completed in the first Semester. Any four skill experiments are to be reported in journal Certified journal is a must to be eligible to appear for the semester end practical. The scheme of examination for the revised course in Physics at the First Year B.Sc.

Semester end examination will be as follows.

Semester End Practical Examination:

Scheme of examination:

There will be no internal assessment for practical. 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 **two hours** per experiment. There will be two experiments through which the candidate will be examined in practical. The questions on 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

SBSPHY201 (Mathematical Physics, Electricity & Electronics)

Course Objective:

1. To learn methods of mathematical physics and develop skills to solve problems.
2. Explain electrical circuits, constructions of network theorems, and their uses.
3. To foster a digital attitude, provide in-depth knowledge of electronics components and circuits

Course Outcomes:

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

1. Understand the basic mathematical concepts and applications of them in physical situations.
2. Demonstrate quantitative problem-solving skills in all the topics covered
3. Understand and apply the basics of electronics and create a working model

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Unit I **15 lectures**

1. Vector Algebra: Vectors, Scalars, Vector algebra, Laws of Vector algebra, Unit vector, rectangular unit vectors, Components of a vector, Scalar fields, Vector fields, Problems based on Vector algebra. Dot or Scalar product, Cross or Vector product, Commutative and Distributive Laws, Scalar Triple product, Vector Triple product (Omit proofs). Problems and applications based on Dot, Cross and Triple products.

2. 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

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Unit: II **15 lectures**

1.. **Alternating current theory**: (Concept of L, R, and C: Review) AC circuit containing pure R, pure L, and pure C, representation of sinusoids by complex numbers, Series L-

R, C-R, and LCR circuits. Resonance in LCR circuit (both series and parallel), Power in ac circuit. Q-factor.

2. AC bridges: AC bridges: General AC bridge, Maxwell, de - Sauty, Wien Bridge, Hay Bridge.

Unit: III **15 lectures**

1. Circuit theorems: (Review: ohm's law, Kirchhoff's laws) Superposition Theorem, Thevenin's Theorem, Ideal Current Sources, Norton's Theorem,
Reciprocity Theorem, Maximum Power Transfer Theorem. Numerical related to circuit analysis using the above theorems.

2. DC power supply: Half wave rectifier, Full wave rectifier, Bridge rectifier, PIV and Ripple factor of full wave rectifier, Clipper and Clampers (Basic circuits only), Capacitor Filter. Zener diode as a voltage stabilizer.

3. Digital Electronics: Logic gates (Review), NAND, and NOR as universal building blocks. EXOR gate: logic expression, logic symbol, truth table, Implementation using basic gates and its applications, Boolean algebra, Boolean theorems. De-Morgan's theorems, Half adder, and Full adder

Note: A good number of numerical examples are expected to be covered during the prescribed lectures

References:

1. MS: Murray R Spiegel, Schaum's outline of Theory and problems of
Vector Analysis, Asian Student Edition
2. CH: Charlie Harper, Introduction to Mathematical Physics, 2009 (EEE) PHI Learning Pvt. Ltd.
3. CR: D. Chattopadhyay, P C Rakshit, Electricity and Magnetism 7th Ed. New Central Book agency.
4. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Additional References:

1. BrijLal, N. Subrahmanyam, Jivan Seshan, Mechanics and Electrodynamics, (S. Chand) (Revised & Enlarged ED. 2005)

2. A K Ghatak, Chua, Mathematical Physics, 1995, Macmillan India Ltd.

3. Ken Riley, Michael Hobson and Stephen Bence, Mathematical Methods for Physics and Engineering, Cambridge (Indian edition).

4. H. K. Dass, Mathematical Physics, S. Chand & Co.

5. Jon Mathews & R. L. Walker, Mathematical Methods of Physics: W A Benjamin Inc.

SEMESTER II

SBSPHY202 (Analog Electronics, Electricity and Applied Physics)

Course Objective:

1. Provide the fundamental skills to understand the basics of semiconductor components like diodes, transistors, relations between current amplification factors, the importance of biasing, and feedback circuit
2. Analyze the relation between conductors, insulators, and in-depth knowledge of material science
3. Learn the basic laws of electrostatics and magnetostatics

Course Outcomes:

1. Understand different biasing techniques to operate the transistor and analyze its stability.
2. Applying basic laws of electrostatics and magnetostatics to demonstrate quantitative problem-solving skills.
3. Understand the basics of crystallography, electrical properties of metals, band theory of solids, types of materials, and superconductivity.

Unit I: **15 lectures**

1. Transistor Biasing, Inherent Variations of Transistor Parameters, Stabilization, Essentials of a Transistor Biasing Circuit, Stability Factor, Methods of Transistor Biasing, Base Resistor Method, Emitter Bias Circuit, Circuit analysis of Emitter Bias, Biasing with Collector Feedback Resistor, Voltage Divider Bias Method, Stability factor for Potential Divider Bias.

2. **General amplifier characteristics:** Concept of amplification, amplifier notations, current gain, Voltage gain, power gain, input resistance, output resistance, general theory of feedback, reasons for negative feedback, loop gain.

Unit II: **15 lectures**

1. The Electric Field: Introduction, Coulomb's Law, The Electric Field, Continuous charge Distribution, Electric Potential, Introduction to Potential, Comments on Potential, The Potential of a Localized Charge Distribution

2. Work and Energy in Electrostatics: The Work Done to Move a charge, The Energy of a Point Charge Distribution

3. Magnetostatics: Magnetic Fields

4. The Biot Savart Law: Steady Currents, The Magnetic Field of a Steady Current Helmholtz coil and solenoid.

Unit III **15 lectures**

Introduction to Materials: Classification of Materials based on structures (Crystalline and Amorphous, single crystal, polycrystalline and nanomaterials) and Functionality (Conducting, insulating, superconducting, reflecting, transmitting etc)

Types of Materials: Metals and alloys, Ceramics, Polymers and Composites, Thin Films, Nanomaterials; Some Physical and Chemical methods of materials synthesis

Properties of materials

Electrical Properties: Review of energy band diagram for materials - conductors, semiconductors and insulators, Electrical conductivity in metals, semiconductors and insulators (dielectrics), effect of temperature on conductivity

Optical Properties: Reflection, refraction, absorption and transmission of electromagnetic radiation in solids.

Magnetic Properties: Origin of magnetism in solids (basic idea), Types of magnetic order (paramagnetism, diamagnetism, antiferro magnetism, ferromagnetism, ferrimagnetism), magnetic hysteresis.

Note: A good number of numerical examples are expected to be covered during the prescribed lectures

References:

1. CR: D. Chattopadhyay, P C Rakshit, Electricity and Magnetism 7th Ed. New Central Book agency.
2. TT: B.L. Theraja and A.K. Theraja, A Textbook of Electrical Technology Vol. I , S. Chand Publication

3. BN: Boylestad and Nashelsky, Electronic devices and Circuit Theory: 7th edition, Prentice Hall of India.

4. VKM: V K Mehta and R Mehta Electronics Principals, Multi coloured Revised 11th Ed. reprint in 2012 S Chand.

5. David J. Griffiths: Introduction to Electrodynamics, Prentice Hall India (EEE) 3rd Ed.

6. A B Bhattacharya, Electronics Principles and Applications, Central publisher.

7. A P Malvino, Digital Principles and Applications: Tata McGraw Hill Tokhiem, Digital electronics, 4th ed, McGraw Hill International Edition.

SEMESTER II

SBSPHYP2 (Practical II)

A) Regular experiments:

1 Flywheel: To determine the moment of inertia of flywheel

2 To study Zener Diode as Regulator

3 To study load regulation of a Bridge Rectifier

4 LR Circuit: To determine the value of given inductance and phase angle

5 CR Circuit: To determine the value of the given capacitor and Phase angle

6 Frequency of AC Mains: To determine the frequency of AC mains.

7 LCR series Resonance: To determine the resonance frequency of the LCR series circuit.

8 To study NAND and NOR gates as Universal Building Blocks

9 To study EX-OR Gate, half adder, and full adder and verify their truth tables.

10 To verify De Morgan's Theorems

11 Thevenin's Theorem: To verify Thevenin's theorem for DC circuits

12 Norton's Theorem: To verify Norton's Theorem for DC circuits

13 LDR Characteristics: To study the dependence of LDR resistance on the intensity of light.

B) List of Demo experiments: (Min. four)

1. Angular Momentum conservation (Rotating Platform)
2. Light-dependent switch
3. Laser beam divergence, Intensity
4. Use of Oscilloscope
5 Charging and discharging of a capacitor
6 Use of PC for graph plotting
7 Clipper and Clamper circuits.

C) Any one out of following is equivalent to two experiments from section A and/ or B.

1. Students should collect the information of at least four Physics events and their outcome. Report that in journal.

2. Students should carry out mini-project up to the satisfaction of professor In-charge of practical

3. Students participated in study tour must submit a study tour report.

Minimum 8 experiments from the list should be completed in the second semester. Any four skill experiments are to be reported in journal Certified journal is must to be eligible to appear for the semester-end practical. The scheme of examination for the revised course in Physics at the First Year B.Sc. Semester end examination will be as follows.