PHYSICS

Course Outcome

Semester 1

Major Course (MJC-I): Introduction to Mathematical Physics & Classical Mechanics

- CO1: Understand mathematical techniques and differences between Newtonian and Analytic Mechanics.
- CO2: Understand scalars, vectors, and D-operator utility.
- CO3: Understand Pseudo force and its applications.
- CO4: Realize Centre of Mass and Laboratory frame concepts.
- CO5: Understand satellite orbits for communication and remote sensing.

Minor Course (MIC-I): Introduction to Mathematical Physics & Classical Mechanics

- CO1 to CO3: Similar to MJC-I but in a more concise format for foundational understanding.

Multidisciplinary Course: Physics Around Us

- CO1: Understand physical laws of climate and atmosphere.
- CO2: Explore Physics applications in agriculture.
- CO3: Understand renewable energy and its physics.

Skill Development: Physics Workshop Skill

- CO1: Apply basic tools in day-to-day applications.
- CO2: Diagnose and fix household electrical circuits.
- CO3: Use skills in practical market contexts.

Value Added Course: Great Indian Scientists

- CO1: Appreciate scientific thinking and its benefits.
- CO2: Learn about Indian scientists' contributions and Indian knowledge systems.
- CO3: Understand Indian women's roles in science.

Semester 2

Major Course (MJC-II): Oscillations and Waves

- CO1: Understand periodic, damped, and forced oscillations.
- CO2: Apply Lissajous Figures to physical problems.
- CO3: Explore working principles of musical instruments.
- CO4: Understand acoustics in building design.
- CO5: Know sound recording and reproduction techniques.

Minor Course (MIC-II): Oscillations and Waves

- Similar to MJC-II but condensed for foundational learning.

Semester 3

MJCPHY03: Thermal Physics & Thermodynamics

- CO1: Understand laws of thermodynamics.
- CO2: Grasp entropy and thermodynamic potentials.
- CO3: Apply Maxwell's relations.
- CO4: Learn kinetic theory, transport phenomena, Brownian motion.

Semester 4

MJCPHY04: Electricity & Magnetism

- CO1: Understand electrostatics fundamentals.
- CO2: Learn dielectric and magnetic material properties.
- CO3: Grasp electromagnetic induction and electric circuits.
- CO4: Gain a foundation for further studies.

MJCPHY05: Mathematical Physics II & Intro to Computational Methods

- CO1: Master complex mathematical analysis.
- CO2: Solve physical differential equations.
- CO3: Use group theory, special functions.
- CO4: Learn computational physics via programming.

Semester 5

MJCPHY06: Electrodynamics and Electromagnetism

- CO1: Analyze Maxwell's equations.
- CO2: Understand EM wave propagation and interactions.
- CO3: Apply energy flow and Poynting theorem.

MJCPHY07: Optics

- CO1: Understand interference, diffraction, and polarization.
- CO2: Use optical instruments for precise measurement.

Semester 6

MJCPHY08: Elements of Modern Physics

- CO1–CO7: Cover wave-particle duality, quantum mechanics, atomic and nuclear physics, radiation detection, etc.

MJCPHY09: Basic Electronics

- CO1: Understand digital circuits and logic gates.
- CO2: Explore semiconductor devices.
- CO3: Learn operational amplifiers and instrumentation.

Semester 7

MJCPHY10: Analytical Mechanics & Special Theory of Relativity

- **CO1:** Understand principles behind Lagrange's and Hamilton's equations.
- **CO2:** Understand canonical transformations and their use.
- **CO3:** Analyze center of mass and laboratory frames for collisions.
- **CO4:** Understand planetary motion and satellite dynamics via gravitation and Kepler’s laws.
- **CO5:** Gain foundational knowledge of special relativity and its implications.

MJCPHY11: Statistical Mechanics

- **CO1:** Gain basic understanding of thermodynamic systems.
- **CO2:** Understand statistical distributions and their physical significance.
- **CO3:** Learn phase transitions and thermodynamic potentials.
- **CO4:** Apply statistical laws in physical systems.
- **CO5:** Prepare for research and advanced studies.

Semester 8

MJCPHY12: Quantum Mechanics & its Applications

- **CO1:** Represent quantum states using ket vectors; operators as observables.
- **CO2:** Understand commutation relations and physical implications.
- **CO3:** Explore dynamics of two-level systems and qubits.
- **CO4:** Build foundation for further research and studies in quantum physics.

MJCPHY15: Solid State Physics

- **CO1:** Understand crystal lattices, symmetry, and structure.
- **CO2:** Explore lattice dynamics and material properties.
- **CO3:** Understand electronic behavior through band theory.
- **CO4:** Analyze dielectric properties and polarizability.
- **CO5:** Build foundation in condensed matter physics and solid-state devices.

MJCPHY16: Physics of Laser and Molecules

- **CO1:** Understand LASER principles and operational mechanisms.
- **CO2:** Explore real-world applications of LASER technology.
- **CO3:** Comprehend molecular formation and bonding concepts.
- **CO4:** Learn principles of resonance spectroscopy.
- **CO5:** Study opto-electronic and photonic devices.
- **CO6:** Develop employable skills in optics-based industries.

Program Outcome (PO) — B.Sc. (Hons) in Physics

After successful completion of the B.Sc. (Hons) Physics program, graduates will be able to:

PO1: Core Conceptual Mastery

Demonstrate a comprehensive and coherent understanding of fundamental concepts across classical mechanics, thermodynamics, electrodynamics, quantum mechanics, statistical physics, electronics, and modern physics.

PO2: Analytical and Problem-Solving Skills

Develop strong analytical abilities and logical reasoning through mathematical formulation and problem-solving strategies applied to physical systems.

PO3: Experimental and Practical Competence

Acquire hands-on skills in experimental physics, including precise measurement techniques, error analysis, and the use of modern instruments and technologies such as oscilloscopes, spectrometers, and computational tools.

PO4: Research and Computational Aptitude

Use computational methods and basic programming (e.g., FORTRAN, algorithm development) to model physical phenomena and analyze data — laying the groundwork for further research or technical careers.

PO5: Multidisciplinary Integration

Apply physical principles in multidisciplinary contexts such as environmental physics, agriculture, renewable energy, and biomedical instrumentation, enhancing their adaptability to diverse career paths.

PO6: Communication and Collaboration

Effectively communicate scientific knowledge through presentations, written reports, and collaborative projects, demonstrating teamwork and leadership in lab and classroom environments.

PO7: Readiness for Higher Education and Research

Be prepared for advanced studies in Physics and allied fields including Data Science, Artificial Intelligence, Electronics, Material Science, and Education. Develop the academic foundation for competitive exams like NET/GATE/JEST.

PO8: Employability and Industry Readiness

Gain professional skills relevant for employment in teaching, R&D labs, electronics, telecommunications, energy sectors, and defense organizations. Acquire capabilities in instrumentation, technical troubleshooting, and circuit design.

PO9: Ethical and Social Responsibility

Understand the societal impact of scientific advancement. Develop ethical awareness, environmental consciousness, and appreciation for scientific contributions by Indian scientists and women in science.

PO10: Lifelong Learning and Innovation

Cultivate scientific curiosity, critical thinking, and a lifelong passion for learning, innovation, and entrepreneurship.

Cross-Cutting Issues in B.Sc. (Hons) Physics Curriculum

1. Professional Ethics

Physics as a discipline cultivates a commitment to scientific integrity and responsible conduct. The curriculum reinforces ethics through:

- **Experimental Integrity:** Courses like *Basic Electronics*, *Optics*, and *Workshop Skills* emphasize accurate data handling, avoiding fabrication or falsification, and proper attribution of sources and results.
- **Research Responsibility:** Topics in *Statistical Mechanics* and *Quantum Mechanics* introduce students to academic honesty and the importance of replicable and transparent research practices.
- **Technology and Society:** Modules on *Electrodynamics*, *LASER Technology*, and *Computational Methods* offer opportunities to discuss the ethical use of emerging technologies in surveillance, weaponry, and AI applications.

2. Gender Sensitivity

The curriculum fosters gender inclusivity by:

- **Highlighting Contributions of Women in Science:** The **Value Added Course: Great Indian Scientists** includes Indian women scientists such as Janaki Ammal, Asima Chatterjee, and Indra Hinduja—promoting gender equity by showcasing role models.
- **Encouraging Equal Participation:** Lab and workshop sessions encourage collaborative learning environments where contributions from all genders are valued equally.
- **Career Neutrality:** Courses are designed without gender bias, enabling all students to aspire to roles in academia, industry, and research regardless of gender.

3. Human Values

Courses inherently incorporate and promote human values such as curiosity, perseverance, and intellectual honesty:

- **Scientific Temper:** Emphasized in foundational courses (e.g., *Classical Mechanics*, *Thermodynamics*), encouraging rational thinking, skepticism, and evidence-based inquiry.
- **Collaborative Skills:** Group projects and lab work develop cooperation, responsibility, and empathy.
- **Historical and Philosophical Perspectives:** Topics like *Special Theory of Relativity* and *Quantum Mechanics* reflect on human curiosity and the pursuit of truth across generations.

4. Environmental Awareness

Environmental themes are embedded through the physics of natural systems and sustainability:

- **Multidisciplinary Course: Physics Around Us**
    - Covers climate science, greenhouse effect, and physics of climate change.
    - Encourages understanding of atmospheric dynamics and sustainable environmental practices.
- **Renewable Energy Education:**
    - Explored in the same course with topics such as solar energy, hydrogen fuel, geothermal energy—linking physics with green technology.
- **Applied Physics and Sustainability:**
    - LASER and solid-state courses discuss low-energy optical devices and efficient material use.
    - Electronics courses address energy efficiency, power conservation, and e-waste considerations.

5. Sustainability

The curriculum supports sustainable thinking through:

- **Energy Efficiency in Devices:** Study of *semiconductors*, *diodes*, and *transistors* enables students to design and understand energy-saving technologies.
- **Sustainable Practices in Laboratories:** Through lab safety protocols and use of minimal hazardous materials.
- **Project Work and Research:** Final-year electives like *Solid State Physics* and *Laser & Molecular Physics* can be directed toward sustainability-focused topics (e.g., solar cells, energy harvesting).

Integration Strategies

To ensure these issues are **transacted effectively**:

- **Seminars and Assignments** on ethics, environmental responsibility, and gender equity.
- **Collaborative Projects** focusing on sustainable technology and social relevance.
- **Guest Lectures** by women scientists, environmental physicists, and industry professionals on ethical practices.
- **SWAYAM/MOOC Integration** for additional awareness-based modules.