Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. III Semester

Paper-Discipline Specific Elective (DSE 1B)

Modern Physics

Course Outcome

CO No.	Course Outcomes	Cognitive Level*
CO -I	Learner will be able to understand the contribution of India to Modern Physics.	U
CO -II	Learner will be able to apply Heisenberg Uncertainty principle to get spectral broadening.	Ap, E
CO -III	Learner will be able to analyze the difference between Zeeman and Paschen-Back effects.	U, An, E
CO -IV	Learner will be able to evaluate Q-values for various Nuclear reactions.	R, U, E, C
CO -V	Learner will be able to design experiments to verify concepts of Modern Physics using simulation.	An, Ap, E,C

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	30	70	**100**

Evaluation Scheme

	Marks	
	Internal	External
Theory	ClassTest/Assignment/Presentation	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs. **Maximum Marks:** 70

Units	Topics	No. of Lectures
I	**Historical Developments in Modern Physics** **1**. Ancient Indian perspectives on atomic and subatomic ideas - Kanada's Vaisheshika philosophy, concepts of Paramanu and energy transformations, Biography and contribution of C.V. Raman in spectroscopy. 2. Philosophical concepts of space, time and relativity-like ideas in Vaiśeşika Darshan; study of Panchakosha with special reference to Manomayakosha and Vigyanamayakosha; and cyclic models of the universe described in the Puranas. 3. Major contributions of BARC Mumbai, TIFR, Nuclear Fuel Complex (NFL) Hyderabad, Institute of Plasma Research Gandhinagar in India's Nuclear program, India's contribution to the International Thermonuclear Experimental Reactor (ITER) project in France. **Activities** 1. Make chart of Nuclear Fission Reactors in India. 2. Debate on the India's contribution to Modern Physics**.** **Keywords/Tags:** Kanada's Vaisheshika philosophy, spectroscopy and Nuclear program	**8**
II	**Quantum Mechanics** 1. Historical background: Limitations of classical physics; failures of classical theory, Blackbody radiation and Planck's quantum hypothesis, Photoelectric effect and Einstein's explanation, Compton effect and photon momentum. 2. Wave-particle duality: de Broglie hypothesis, Davisson Germer experiment and matter waves, Concept of wave packets, group and phase velocity, Heisenberg's uncertainty principle and its experimental verification, Wave function and its physical interpretation, Probability density, normalised and orthogonal wave function. 3. Operators, eigenvalues, and eigenfunctions, expectation values and	**13**

	observables, time-dependent and time independent Schrödinger equations, Application: particle in a box (1D). **Activities** 1. Study Photoelectric effect using virtual lab. 2. Study Blackbody spectrum using PhET (Physics Educational Technology) Simulation. **Keywords/Tags:** Blackbody radiation, Heisenberg's uncertainty principle and Schrödinger equations.	
III	**Atomic Structure and Spectra** 1. Failure of Rutherford and Bohr models (qualitative discussion), Quantum mechanical model of hydrogen atom, Quantum numbers, atomic orbitals, and probability distributions. 2. Vector model of atom, Pauli's exclusion principle, space quantization, Electron spin and Stern-Gerlach experiment, Fine structure of spectral lines, Zeeman and Paschen-Back effects (qualitative), X-ray spectra and Moseley's law. **Activities** 1. Study Rutherford scattering and Stern-Gerlach experiment using PhET Simulation. 2. Discuss the contribution of Moseley in framing the modern periodic table. **Keywords/Tags:** Quantum numbers, space quantization, Stern Gerlach experiment.	**13**
IV	**Molecular Physics and Spectroscopy** 1. Molecular bonds: Rotational and vibrational energy levels, Rotational spectra of diatomic molecules, Vibrational spectra: infrared absorption and selection rules, Raman effect - theory and applications. 2. Electronic spectra of molecules, Fluorescence and phosphorescence, Lasers: principle, population inversion, spontaneous and stimulated emission, Basic types of lasers and their applications. **Activities** 1. Make chart showing application of Raman spectra in material characterization. 2. Study emission spectra of Mercury and Hydrogen using Virtual lab. **Keywords/Tags:** Rotational spectra, vibrational spectra, spontaneous and stimulated emission.	**13**

V	**Nuclear and Particle Physics** 1. Structure of nucleus: size, charge, mass, density, binding energy, mass defect and nuclear stability, Radioactivity: laws of decay, half-life, mean life, Alpha, beta and gamma decay mechanisms, nuclear reactions and Q-value. 2. Nuclear fission and fusion; energy release and applications, Elementary particles: classification and properties, basic idea of quarks and fundamental interactions. **Activities** 1. Make a chart of classification of elementary particles. 2. Group discussion on alpha, beta and gamma decay mechanism. **Keywords/Tags:** Binding energy, Radioactivity, Nuclear fission and fusion.	**13**

References

Test/Reference Books:

1The Vaisheshika Sutras of Kanada, (trans. Nandalal Sinha).

2. Chattopadhyaya Debiprasad, History of Science and Technology in Ancient India: The Beginnings.

3. Keswani G. H., Raman and His Effect, National Book Trust.

4. Beiser Arthur, "Concepts of Modern Physics", Sixth Edition, McGraw-Hill Higher Education 2003.

5. Thornton Stephen T. and Rex Andrew, "Modern Physics for Scientist and Engineers" Fourth Edition, Cengage Learning 2013.

6. Murugeshan R. and Sivaprasathi Kiruthiga, "Modern Physics" S. Chand, 2013.

7. Tipler Paul A. and Llewellyn Ralph A.," Modern Physics", Fifth Edition, W.H. Freeman and Company, New York, 2008.

8. C.N. Banewell, Fundamental of molecular spectroscopy, Mcgraw hill book company

8. मध्य प्रदेश हिंदी ग्रंथ अकादमी, भोपाल द्वारा प्रकाशित पुस्तकें।

Web Links:

1. https://onlinecourses.nptel.ac.in/noc25ph07/preview Elements of Modern Physics by Prof Saurabh Basu IIT Guwahati.

2. https://mp-amrt.vlabs.ac.in/List%20of%20experiments.html

3. https://phet.colorado.edu/sims/html/blackbody-spectrum/latest/blackbodyspectrum all.html
4. https://www.vlab.co.in/ba-nptel-labs-physical-sciences