Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. III Semester

Paper-Minor (M)

Electricity, Magnetism and Wave Propagation

Course Outcome

CO No.	Course Outcomes	Cognitive Level*
CO -I	Learner will Understand and apply Coulomb's law, Gauss's law, and potential theory to analyze electrostatic fields and understand polarization and dielectric behavior in materials. .	U, Ap
CO -II	Learner will Analyze magnetic fields using Biot-Savart and Ampere's laws and evaluate magnetic properties of materials in terms of magnetization, susceptibility, and permeability.	An, E, R
CO -III	Learner will derive and understand Maxwell's equations to explain electromagnetic induction, displacement current, and the conservation of energy through Poynting's theorem	U, E, C
CO -IV	Learner will explain and analyze electromagnetic wave propagation, reflection, and refraction in vacuum and linear media using wave and boundary equations.	An, Ap, E
CO -V	Learner will Integrate ancient Indian philosophical ideas (Vaiseşika Darśana) with modern electromagnetic theory to develop a holistic understanding of physical interactions.	U, An

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	3	30	70	**100**
Practical	1	30	70	**100**
Total	**4**	**200**		

Evaluation Scheme

	Marks	
	Internal-30 Marks	**External-70 Marks**
Theory	Class Test/Assignment/Presentation	1 External Exams (At the End of Semester)
Practical	Class interaction, Attendance, Assignments	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: 45 Hrs. **Maximum Marks:** 70

Units	Topics	No. of Lectures
I	**Historical background** 1. Ancient Indian Concepts of Charge and Field, introduction to Rayi and Prana, Exploration of the Vaisheṣhika Darsana and its theory of Padartha, particularly the concepts of Dravya, Guna and Karma, which form an ontological basis for describing physical phenomena. 2. Ancient observations related to lightning, attraction phenomena and natural energy. A**ctivities:** 1. Study and analysis of ancient Indian concepts of lightning, magnetism, and energy described in texts such as the Atharva Veda. 2. Group discussion on the scientific aspects associated with traditional descriptions of the floating Somnath Lingam. **Keywords/Tags:** Rayi and Prāṇa, Vaisheṣhika Darsana.	5
II	**Electrostatics** 1. Coulomb's Law, Electric field, Continuous Charge Distributions, Gauss's Law and its applications, Curl of Electric Field, Introduction to electric potential. Conductors: Basic Properties, Induced Charges. 2. Electric fields in Matter: Polarization (P), Bound Charges, Electric Displacement (D), Linear Dielectrics (Susceptibility and Permittivity), Boundary Conditions. **Activities:** 1. Students will demonstrate the force between two charged balloons to understand Coulomb's Law.	10

	2. Students will draw a diagram showing alignment of dipoles in a dielectric placed in an electric field. **Keywords/Tags:** Coulomb's Law, Electric Potential.	
III	**Magnetostatics** 1. Lorentz force, Magnetic field, Force and Currents, Biot Savart law, Magnetic field of a steady current, Divergence and Curl of Magnetic Field, Ampere's law and It's applications, Magnetic vector potential. 2. Magnetic Fields in matter: Magnetization (M), Bound currents Derivation of Curl $M=J_b$ for a non-uniformly magnetized substance, Auxiliary field(H), Magnetic susceptibility and permeability. **Activities:** 1. Students will draw the magnetic field pattern around straight current-carrying wire using compass needles. 2. Students will tabulate examples of materials with high and low magnetic susceptibility and discuss their uses. **Keywords/Tags:** Lorentz Force, Magnetization, Auxiliary Field, Magnetic Permeability.	**10**
IV	**Electrodynamics and Conservation Laws** 1. Electromagnetic Induction, Faraday's Law, Integral and differential forms of Faraday's law, Induced Electric Field, Electromotive Force (EMF), Self and Mutual Inductance, Energy in Magnetic Fields, Displacement Current, Correction in Ampere's Law, Maxwell's Equations (in Vacuum and in Medium), Boundary Conditions. 2. Conservation Laws: Continuity Equation, Poynting's Theorem (Energy Conservation). **Activities:** 1. Students will verify Ohm's Law by measuring voltage and current in a simple circuit. 2. Students will make chart of Maxwell's equations and identify the role of displacement current in completing Ampere's Law.	**10**

	Keywords/Tags: Faraday's Law, Inductance, Displacement Current, Maxwell's Equations.	
V	**Electromagnetic Waves** 1. Wave Equation, Electromagnetic Waves in Vacuum (monochromatic plane waves), Energy and Momentum in EM Waves. 2. Propagation in Linear Media, Reflection and Refraction (Normal Incidence, Snell's Law, Fresnel Equations qualitative study for parallel/perpendicular polarization), Brewster's Angle, Total Internal Reflection. **Activities:** 1. Students will draw a diagram showing electric and magnetic field components of a plane electromagnetic wave. 2. Students will verify Snell's Law using a glass slab and a laser light. **Keywords/Tags:** Wave Equation, Electromagnetic Waves.	**10**

References

Test/Reference Books:

Suggested Readings

1Mahajan S. and Choudhury, "Electricity, Magnetism & Electromagnetic Theory",2012, Tata McGraw.

2. Griffiths D.J., "Electricity and Magnetism", 3rd Edn., 1998, Benjamin Cummings.

3. A Concise History of Science in India, D. M. Bose, S. N. Sen, and B. V. Subbarayappa, Indian National Science Academy (INSA), New Delhi.

4. Vaiśeşika Philosophy of Nature, Debabrata Sinha, Bhartiya Vidya Prakashan.

5. Tayal D. C., "Electricity and magnetism", Himalaya Publishing Co.

6. Murugesan, "Electricity and magnetism", S. Chand & Co.

7. Feynman R. P., Leighton R.B., Sands M., "Feynman Lectures Vol.2", 2008, Pearson Education.

8. Kshetrimayun R. S., "Electromagnetic field theory", 2012, Cengage Learning.

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

Web Links:

1. https://youtu.be/NED2C18µ900 Electromagnetic Thery by Prof. D.K. Ghosh, Department of Physics, IIT Bombay.
2. https://www.eshiksha.mp.gov.in/mpdhe /Learning Management System, Department of higher education, Government of Madhya Pradesh (M.P.)

List of Experiments

Credit: 1 Hours:30

1. To draw the B-H curve and determination of Hysteresis loss.
2. Determination of voltage, frequency and phase difference using CRO.
3. To study of the charging and discharging of a condenser through a resistor.
4. Determination of impedance and power factor using LCR circuit.
5. Study of frequency response curve of a series LCR circuit and determination of resonant frequency, Quality factor and Band width.
6. To study frequency response curve of a parallel LCR circuit and determination of anti-resonant frequency and Quality factor.
7. Determination of Dielectric constant of Kerosene by resonance method.
8. To study the magnetic field along the axis of a circular coil.
9. Determination of M and H using vibrational magnetometer and deflection magnetometer.
10. Comparison of capacity of two capacitors using Ballistic Galvanometers.

REFERENCES

1. Prakash I. & Ramakrishna, "A Text Book of Practical Physics", Kitab Mahal, 2011,11/e.
2. Squires G. L., "Practical Physics", Cambridge University Press, 2015, 4/e.
3. Flint B. L. and Worsnop H. T., "Advanced Practical Physics for students", Asia Publishing House, 197.
4. Chattopadhyay D. & Rakshit P. C., "An Advanced Course in Practical Physics", New Central Book Agency.
5. Singh S.P., "Advanced Practical Physics", Pragati Prakashan.
6. Tayal D. C., "University Practical Physics", Himalaya Publishing House
7. Kumar P. R. Sasi, "Practical Physics", PHI Publication
8. Srivastava Anchal, Shukla R. K., "Practical Physics", New Age International Publishers
9. Agarwal D. C., "Experimental electronics", Technical Publishing House.
10. Srivastava J. P., "Elements of Solid-state Physics", PHI Publication.
11. Ghosh & Majumdar , Practical Physics, Modern Book Agency
12. मध्य प्रदेश हिंदी ग्रंथ अकादमी, भोपाल द्वारा प्रकाशित पुस्तक