Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. IV Semester

Paper-Major& Minor

ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Course Outcome

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level*
CO -I	The student will arrive at an understanding of electrostatics, Gauss's theorem, Gauss's law and their application,	1,2,3,4	U, R, E, Ap
CO -II	The student will arrive at an understanding of Magnetostatistics with emphasis on Lorentz force, Biot-Savart law ant its application, Ampere's law, free and bound currents, magnetization vector, magnetic substances.	1,2,3,4,5	U, Ap, R, E
CO -III	The student will arrive at an understanding of steady & non steady current, a-c & dc circuits, and various network theorem.	1,2,3,4	R, U, C
CO -IV	The student will arrive at an understanding of the motion of charged particles in electric and magnetic fields, the relevant equipment and their use	1,2,3,4	U, R, Ap
CO -V	The student will arrive at an understanding of electrodynamics with emphasis on Faraday's laws, Maxwell equations and their application, Fresnel's equations,	1,2,3,4	U, R, Ap, C
CO -VI	The student will arrive at an understanding of electromagnetic waves with emphasis on, reflection, refraction and polarization at different media	1,2,3	U, Ap, E, C, An

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	40	60	**100**
Practical	2	40	60	**100**
Total	**6**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	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:** 60

Units	Topics	No. of Lectures
I	**Electrostatics** 1. An overview of thermal and hydroelectric power plants in Madhya Pradesh. 2. Electrostatic field; Electric flux; Gauss's theorem of electrostatics; Applications of Gauss theorem: Electric field due to infinite long charged wire; Uniformly charged spherical shell and solid sphere; Charged plate; Conservative nature of electrostatic field Laplace and Poisson's equations; Uniqueness theorem. 3. Dielectrics; Polar and non-polar molecules; Parallel plate capacitor with a dielectric; Electrical susceptibility and dielectric constant; Polarization and Polarization vector (P); Displacement vector (D); Intensity of Electric field (E); Relationship between D, E and P. 4. Gauss's law in dielectrics; Clausius-Mossotti relation, Langevin-Debye formula; Ferroelectric and Paraelectric materials; Hysteresis loop for ferroelectrics. **Keywords/Tags:.** Hydroelectric power plant, Electrostatic field, Dielectrics, Polarization vector Displacement vector	12
II	**Magnetostatics** 1. Lorentz force equation and magnetic field B; Biot-Savart's law; Calculation of magnetic intensity H for solenoid and anchor ring. 2. Ampere's circuital law and its applications for solenoid and Toroid; Basic law of magnetostatics in differential form $A \times B = \mu_0 J$, $A.B = 0$ **;** Free and bound currents; Magnetization and magnetization vector **M;** Magnetic permeability and susceptibility; Derivation of $A \times M = J_b$ for a non-uniformly magnetized substance; Relationship between **B, H** and **M.**	12

	3. Diamagnetic, Paramagnetic and Ferromagnetic substances; B-H Curve and Hysteresis loss. 4. General idea about AC and DC motors, Motor winding. 5. **Keywords/Tags:** Magnetic field, Magnetization, Hysteresis loss, Motor winding	
III	**Current electricity** 1. Network theorems: Concept of ideal current and voltage sources; Thevenin's theorem; Norton's theorem; Millman's theorem; Maximum power transfer theorem. 2. Transient current: Growth and decay of current in LR circuit; Charging and discharging of a capacitor through resistor; Measurement of high resistance by leakage; Charging and discharging of a condenser through an inductance and resistance. 3. Alternating current: Complex number and their applications in alternating current circuits (RL, RC and LC); Series LCR (acceptor) and parallel LCR (rejector) circuits; Power factor. 4. A.C. bridges: Maxwell's bridge; Owen'sbridge; Anderson's bridge; Kelvin's bridge. **Keywords/Tags:** Network theorems, Transient current, A.C. bridges.	**12**
IV	**Motion of charged particles in electric and magnetic field** 1. Motion of charged particles in electric and magnetic field, Construction and working principle of Cyclotron and Betatron; Thomson's method for the determination of specific charge (e/m) of electron. 2. Ballistic galvanometer: Torque on a current loop; Current and charge sensitivity; Electromagnetic damping, Logarithmic damping; CDR. 3. Introduction to CRO: Block Diagram of CRO; Applications	**12**

	of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference Electromagnetic induction: Faraday's law; Lenz's law; Integral and differential forms of Faraday's law, Self and mutual inductance; Reciprocity theorem; Self-mutual of coil; Mutual inductance of two coils; Energy stored in magnetic field. **Keywords/Tags:** Motion of charged particles, specific charge, Ballistic galvanometer, CRO, Electromagnetic induction.	
V	**Electrodynamics** 1. Equation of Continuity for current; Maxwell's displacement current; Derivation of Maxwell's equations; Poynting theorem. 2. Electromagnetic wave equations; Plane electromagnetic wave in vacuum and dielectric media; Reflection and refraction at a plane boundary of dielectric; Polarization by reflection and Fresnel's equation; Brewster's Law. 3. Electromagnetic Waves in conducting medium; Reflection and refraction of Electromagnetic wave by the ionosphere; Secant law; Skip distance and maximum usable frequency. **Keywords/Tags:** Displacementcurrent, Poynting vector, Electromagnetic wave, Polarization by reflection.	**12**

List of Experiments

1) To study the frequency response curve of series LCR Circuit. and determination of resonant frequency, Quality factor and Band width.
2) To study the charging and discharging of a capacitor through high resistance.
3) To determine the frequency of A.C. Mains with the help of wire vibrating under Lorentz force.
4) To Plot Graph showing variation of magnetic field with distance along axis of a circular coil carrying current.
5) To draw the B-H curve and determination of Hysteresis loss. **(SPONSARED BY DBT STAR)**
6) Determination of voltage, frequency and phase difference using CRO.
7) Study of sensitivity of CRO.
8) Verification of the Thevenin's theorem.
9) Verification of the Norton's Theorem.
10) Verification of the maximum power transfer theorem
11) Verification of the superposition theorem.
12) Measurement of self-inductance using Maxwell's bridge.
13) Measurement of unknown inductance using Kelvin's bridge.
14) Determination of self-inductance by Anderson's bridge.
15) Determination of impedance and power factor using LCR Circuit.
16) To study of frequency response curve of a parallel LCR circuit and determination of anti-resonant frequency and Quality factor.
17) Determination of Dielectric constant of Kerosene by resonance method.
18) Determination of Self Inductance of a Coil by Rayleigh's
19) Method using Ballistic Galvanometer.
20) Verification of Millman's theorem
21) To study the magnetic field along the axis of a circular coil.
22) Determination of M and H using vibrational Magnetometer and Deflection Magnetometer.
23) Comparison Of Capacity Of Two Capacitors Using Ballistic Galvanometer.
24) Serial And Parallel Resonant Circuits (Sponsored By Dbt Star)
25) Maxwell's Bridge : Determination Of Self-Inductance Of A Coil (Sponsored By Dbt

Star)

26) Dipole Moment Of An Organic Molecule Acetone Sponsored By Dbt Star)

27) Measurement Of Low Resistance. (Sponsared By Dbt Star)

28) To Study The Faraday Effect & To Determine Verdet's Constant Sponsored By Dbt Star)

29) Study Of Lcr Transient Response (Sponsored By Dbt Star)

30) ## Other Experiments Of The Same Difficulty Level May Be Added. ## Student Needs To Perform At Least 06 Experiments.

Suggested Readings:

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. Chattopadhyay **D.,** Rakshit P.C. and Saha B., "**An Advanced Course in Practical Physics**", New Central Book Agency P. Ltd.
6. Singh S.P., "**Advanced Practical Physics**", Pragati Prakashan.
7. Tayal D. C., "**University Practical Physics**", Himalaya Publishing House
8. Kumar P. R. Sasi, " **Practical Physics**", PHI Publication
9. Srivastava Anchal, Shukla R. K., "**Practical Physics**", New Age International Publishers.
10. Agarwal D. C., "**Experimental electronics**", Technical Publishing House.
11. Srivastava J. P., "**Elements of Solid state Physics**", PHI Publication.
12. Advanced Practical Physics (Vol. 1 & Vol. 2) B.Ghosh and K.G.Mazumder, Sreedhar Publ.
13. Instruction Manual for doing experiments in Physics by R.Shrinivasan and K.R. Pariolkar

Suggestive digital platforms web links

https://www.vlab.co.in/broad-area-physical-sciences, Virtual Labs (Physical Sciences), Ministry of Education

https://storage.googlecapis.com/uniquecourses/online.html, SWAYAM Online Course

B.Sc IV Sem

(Electricity, Magnetism and Electromagnetic theory)

Elective

Course Outcome

CO No.	Course Outcomes	PSOs Addressed	Cognitive Level*
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Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	3	40	60	**100**
Practical	1	40	60	**100**
Total	**4**	**200**		

Evaluation Scheme

	Marks	
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Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 3.5 Hrs. per week

Total No. of Lectures: 45 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Electrostatics** 5. An overview of thermal and hydroelectric power plants in Madhya Pradesh. 6. Electrostatic field; Electric flux; Gauss's theorem of electrostatics; Applications of Gauss theorem: Electric field due to infinite long charged wire; Uniformly charged spherical shell and solid sphere; Charged plate; Conservative nature of electrostatic field Laplace and Poisson's equations; Uniqueness theorem. 7. Dielectrics; Polar and non-polar molecules; Parallel plate capacitor with a dielectric; Electrical susceptibility and dielectric constant; Polarization and Polarization vector (P); Displacement vector (D); Intensity of Electric field (E); Relationship between D, E and P. 8. Gauss's law in dielectrics; Clausius-Mossotti relation, Langevin-Debye formula; Ferroelectric and Paraelectric materials; Hysteresis loop for ferroelectrics. **Keywords/Tags:.** Hydroelectric power plant, Electrostatic field, Dielectrics, Polarization vector Displacement vector	12
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	7. Introduction to CRO: Block Diagram of CRO; Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. 8. Electromagnetic induction: Faraday's law; Lenz's law; Integral and differential forms of Faraday's law, Self and mutual inductance; Reciprocity theorem; Self-mutual of coil; Mutual inductance of two coils; Energy stored in magnetic field. **Keywords/Tags:** Motion of charged particles, specific charge, Ballistic galvanometer, CRO, Electromagnetic induction.	

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Learning Resources

Text Books, Reference Books, Other resources

Suggested Readings:

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

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

3 **Electricity and magnetism**: Murugesan, S. Chand & Co.

4 **Feynman Lectures Vol.2:** Feynman R. P., Leighton R.B., Sands M., 2008, Pearson Education

5 **Electromagnetic field theory:** Kshetrimayun R. S., 2012, Cengage Learning.

6 **Physics for Degree Students:** C.L. Arora and P.S. Hemne, S.Chand Publications.

7 **Electricity and Magnetism** : S.S.Atwood, Dover Publication

List of Experiments

Credit Value: 1

No. Of Practical hours: 15

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2. To study the charging and discharging of a capacitor through high resistance.
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26. Dipole Moment of an organic Molecule Acetone **(SPONSARED BY DBT STAR)**
27. Measurement of low resistance.**(SPONSARED BY DBT STAR)**
28. To study the Faraday Effect & to determine Verdet's constant**(SPONSARED BY DBT STAR)**
29. Study of LCR transient response**(SPONSARED BY DBT STAR)**

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Student needs to perform at least 06 experiments.

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13. Instruction Manual for doing experiments in Physics by R.Shrinivasan and K.R. Pariolkar

Suggestive digital platforms web links

https://www.vlab.co.in/broad-area-physical-sciences, Virtual Labs (Physical Sciences), Ministry of Education

https://storage.googlecapis.com/uniquecourses/online.html, SWAYAM Online Course