Indian Association for the Cultivation of Science

School of Physical Sciences

Integrated Bachelors-Masters Program in Science

PHS 1201: Electricity, Magnetism & Optics

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1　Main points to remember

- **Course Webpage**: I have created a webpage, where all the details regarding this course will be posted. You are encouraged to check the webpage in regular intervals. You can access it by clicking here. Or, copy paste the following url to your browser: *https://sumantachakraborty.weebly.com/em-and-optics.html.*

- **Assignments and Evaluation**: I will hand over **five** assignments over the duration of the course. You have to work out the assignments of your own and some of the problems will also be discussed at the tutorial. The evaluation will be based on the **five** assignments, mid semester examination and the final examination. All the examinations will be closed book, closed note. Please contact the academic office for any other issue regarding the course.

- **Communications**: The main mode of communication outside class will be through emails. Thus I would request all of you to check emails at least once everyday. The assignments as well as other instructions will be handed over through emails only. The classes will be on **Wednesday** and **Thursday** from **10:00** am. The tutorial will be from **3:00** pm on **Friday**.

2　Syllabus

Electric Field and Electric Potential

- Electric field lines and Electric flux.

- Gauss's law and applications to charged distributions with spherical, cylindrical and planar symmetry.

- Conservative nature of electrostatic field. Electrostatic potential. Laplace's and Poisson's equations. Electrostatic energy of system of charges.

- Capacitance of a system of charged conductors. Parallel plate capacitor and capacitance of an isolated conductor.

Magnetic Field

- Magnetic force between current elements and definition of magnetic field.

- Biot-Savart's law and its simple applications: straight wire and current loop.

- Current loop as a magnetic dipole and its dipole moment (analogy with electric dipole).

- Ampere's circuital law and its application. Vector potential.

- Magnetic force on (i) point charge, (ii) current carrying wire and (iii) between current elements. Torque on a current loop in a uniform magnetic field.

Electromagnetic Induction:

- Faraday's law. Lenz's law. Self-inductance and mutual inductance. Reciprocity theorem. Energy stored in a magnetic field.

- Maxwell's equations and wave equation in isotropic medium.

Electrical Circuits:

- DC and AC circuits. Kirchoff's laws, Complex reactance and impedance.

- Series and parallel LCR circuit, Resonance, Power dissipation, Quality factor, Band width.

Optics:

- Lens formula, Fermats principle.

- Interference, Young's double slit experiment, Lloyd's mirror, Fresnel's Bi-prism, Newton's rings.

- Diffraction, Single and double slit, Diffraction grating, Polarization, Plane and circular polarization, Optical activity.

- Laser, Michelson and Fabry-Perot Interferometer.

3   Books and Articles

- *Introduction to Electrodynamics* — D.J. Griffiths — Pearson Education.

- *Lectures on Electromagnetism* — Ashok Das — Hindustan Book Agency.

- *Classical Electrodynamics* — J.D. Jackson — John Wiley and Sons.

- *Electricity and Magnetism* — D. Chattopadhyay and P.C. Rakshit — Central Book Agency.

- *The Classical Theory of Fields* — L.D. Landau and E.M. Lifschitz — Elsevier.

- *Foundations of Electromagnetic Theory* — Reitz, Milford and Christy — Narosa Publication.

- *Optics* — E. Hecht and A.R. Ganesan — Pearson Education.

- *Geometrical and Physical Optics* — P.K. Chakrabarti — Central Book Agency.

- *Geometrical and Physical Optics* — R.S. Longhurst — Orient Longman.

- *A Textbook on Light* — B. Ghosh and K.G. Mazumdar — Sreedhar Publishers.

- *Fundamentals of Optics* — F.A. Jenkins and H.E. White — McGraw-Hill International Publishers.

- *Optics* — A. Ghatak — McGraw-Hill Publishers.

- *Principles of Optics* — M. Born and E. Wolf — Cambridge University Press.

4   Time Scale

The course will start from **5th April** and will continue till **2nd July**. In total this course will continue for **thirteen** weeks and possibly we will have around **25** classes. Below a tentative course structure has been presented, I will try to stick to this schedule. All the classes which have already been taken will be strike through.

- **Class-01 (07.04.2021)** — Coulomb's law, Electric field, Electric field lines, Electrostatic potential, Poisson's and Laplace's equations.

- **Class-02 (08.04.2021)** — Examples of infinite uniform line charge distribution, uniform spherical charge distribution.

- **Class-03 (09.04.2021)** — Examples of infinite uniform surface charge distribution, Uniqueness theorem.

- **Assignment-01 (12.04.2021)** — First assignment will be handed over.

- **Tutorial-01 (14.04.2021)** — First assignment will be discussed.

- **Class-04 (15.04.2021)** — Energy in electrostatic field, Conductors and Capacitors.

- **Class-05 (16.04.2021)** — Magnetic force, magnetic field and Biot-Savart's law.

- **Class-06 (21.04.2021)** — Application of Biot-Savart's law for straight current carrying wire and circular loop.

- **Class-07 (22.04.2021)** — Current loop as a magnetic dipole and its magnetic moment.

- **Class-08 (23.04.2021)** — Ampere's law and its application, Notion of vector potential.

- **Submission-01 (25.04.2021)** — First assignment needs to be submitted.

- **Assignment-02 (26.04.2021)** — Second assignment will be handed over.

- **Class-09 (28.04.2021)** — Magnetic force on point charge, current carrying wire and between current elements. Torque on current loop.

- **Tutorial-02 (29.04.2021)** — Second assignment will be discussed.

- **Class-10 (30.04.2021)** — Basic introduction to Faraday's law and Lenz's law.

- **Class-11 (05.05.2021)** — Self inductance and mutual inductance. Reciprocity theorem.

- **Tutorial-03 (06.05.2021)** — Second assignment will be discussed.

- **Class-12 (07.05.2021)** — Energy stored in a magnetic field.

- **Submission-02 (09.05.2021)** — Second assignment needs to be submitted.

- **Assignment-03 (10.05.2021)** — Third assignment will be handed over.

- **Class-13 (12.05.2021)** — Maxwell's equations and electromagnetic wave.

- **Tutorial-04 (13.05.2021)** — Third assignment will be discussed.

- **Class-14 (19.05.2021)** — Future directions and further implications.

- **Class-15 (20.05.2021)** — DC and AC circuits and Kirchhoff's laws. Introduction to reactance and impedance.

- **Class-16 (21.05.2021)** — Series and Parallel LCR circuit, Resonance, Power dissipation, Quality factor, Band width.

- **Submission-03 (23.05.2021)** — Third assignment needs to be submitted.

- **Assignment-04 (24.05.2021)** — Fourth assignment will be handed over.

- **Class-17 (26.05.2021)** — Fermat's Principle; Reflection and refraction in flat surfaces; Reflection in curved surface.

- **Class-18 (27.05.2021)** — Refraction in curved surface; Derivation of Len's formula; Equivalent forms.

- **Class-19 (28.05.2021)** — Basics of interference; Young's Double Slit Experiment.

- **Class-20 (02.06.2021)** — Shape of interference fringes.

- **Tutorial-05 (03.06.2021)** — Fourth assignment will be discussed.

- **Class-21 (04.06.2021)** — Llyod's Mirror and Fresnel's Bi-Prism; Interference in thin film.

- **Submission-04 (06.06.2021)** — Fourth assignment needs to be submitted.

- **Assignment-05 (07.06.2021)** — Fifth assignment will be handed over.

- **Class-22 (09.06.2021)** — Newton's ring; Fabry-Perot and Michelson interferometer.

- **Tutorial-06 (10.06.2021)** — Fifth assignment will be discussed.

- **Class-23 (11.06.2021)** — Basics of diffraction; Diffraction from single and double slit; Basic results and applications.

- **Class-24 (16.06.2021)** — Idea of diffraction grating; Possible applications.

- **Tutorial-07 (17.06.2021)** — Fifth assignment will be discussed.

- **Class-25 (18.06.2021)** — Polarization of light; Plane, circular and elliptic polarizations.

- **Submission-05 (20.06.2021)** — Fifth assignment needs to be submitted.

- **Class-26 (23.06.2021)** — Birefringence, Optical activity.

- **Class-27 (24.06.2021)** — Introduction to Laser.