# Advanced Electrodynamics (PH6041)

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| Program | **MS/PhD** |
| Credit Hours | **3** |
| Duration | **15 Weeks** |
| Prerequisites | **Electricity and Magnetism. Calculus.** |
| Resource Person | **Dr. M. Imran Jamil** |
| Counseling Timing | **Tuesday 02:00am-04pm**  **Thursday 11am-01pm**  **Friday 03pm-05pm** |
| Contact | **3S-38, Cell# 03228439947** |

**Chairman/Director Programme signature………………. Dean’s signature…………**

**Date………………………………….**

**Learning Objective**

At the completion of the course student will be able to:

1. Solve advanced problems of electromagnetism.
2. Apply Maxwell’s equations to explain various electromagnetic wave phenomena.
3. Solve simple problems of electrodynamics
4. Introduce covariant form of Maxwell’s equations

**Learning Methodology**

There will be one class of three hours each week. In addition, students should expect to spend at least ninehours each week on their homework.

**Grade Evaluation Criteria**

Following is the criteria for the distribution of marks to evaluate final grade in a semester.

**Marks Evaluation Marks in percentage**

Quizzes 15

Assignments /Presentations 10

Mid Term 25

Attendance & Class Participation

Term Project

Final exam 50

Total 100

**Recommended Text Books**

1. “Classical Electrodynamics” by Walter Greiner, Springer, (1998).
2. “Classical Electrodynamics” 3rd edition by Jackson, John Wiley & Sons, (1999).
3. “Introduction to Electrodynamics” 3rd edition by D. Griffiths, Prentice Hall, ( 2009).

**Reference Books**

* “Electrodynamics of Continuous Media” by L. D. Landau and E. M. Lifshitz, Pergamon Press, (1984).
* “Classical Electrodynamics” by Julian Schwinger, Lester L. DeRaad, Kimball A. Milton, Wu-yang Tsai, Perseus Books, Reading, Massachusetts, (1998).
* “Quantum Field Theory” by F. Mandl and G. Shaw, John Willey and Sons, (1986).
* Mathematical Physics by Eugene Butkov, Addison-Wesley Publishing Company, London, 1973.
* Mathematical methods for physicists, sixth edition, by George B. Arfken, Hans J. Weber. Elsevier academic press, 2005.

**Calendar of Course contents to be covered during semester Fall2022**

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| **week** | **Activity** | **Reference** |
| **1** | **The vector calculus and Levi-Civita Symbols (continue)** | Mathematical Physics by Butkov, `Mathematical Methods for Physicists' by Arfken and Weber |
| **2** | **Levi-Civita Symbols , Differential calculus** | Griffiths, Mathematical Physics by Butkov. |
| **3** | **The Divergence, The Curl, The Gradient** | Griffiths, Mathematical Physics by Butkov. |
| **4** | **Product Rules.**  **Integral Calculus, Line, Surface and volume integrals** | Mathematical Physics by Butkov, Griffiths |
| **5** | **The Fundamental Theorem for Divergence, The Fundamental Theorem for Curls.** | Griffiths |
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| **6** | **Electrostatics, Electric Field Intensity and potential, Gauss ‘Law, Poisson equation, Laplace equation.** | Greiner |
| **7** | **The energy of a charge distribution.** | Greiner, Jackson, Griffiths |
| **8** | **Green’s Theorem, Green’s function, The first and the second Green’s theorem.** | Greiner, Jackson |
| **9** | **Dirichlet and Neuman boundary conditions. Uniqueness of the solutions. The Grounded Conducting sphere in the field of charge q. Continue.** | Greiner, Jackson |

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| **10** | **The Grounded Conducting sphere in the field of charge q, The method of images.** | Greiner, Griffiths, Jackson**.** |
| **11** | **Electrostatic Energy and Forces in a Dielectric. The minimum property of the electrostatic field energy, Change of energy by a dielectric object.** | Greiner, Jackson |
| **12** | **Foundations of Magnetostatics, The Biot-Savart law, Force between two closed Currents** | Greiner |
| **13** | **Ampere’s first Law, Ampere’s second Law.** | Greiner |
| **14** | **The Vector Potential, The behavior of B and H.** | Greiner, Jackson Griffiths |

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| **15** | **Faraday’s Law of Induction, Maxwell’s equations,**  **Covariant formulation of Maxwell’s equation.** | Greiner, Jackson, Griffiths |