This is a tentative schedule of what we will cover in the course. It is subject to change, often without notice. These will occur in response to the speed with which we cover material, individual class interests, and possible changes in the topics covered. Use this plan to read ahead from the lecture notes and following textbooks, so you are better equipped to ask questions in class.

1. **Special Relativity with basics of relativistic Field Theory**

   - **PRELIMINARIES**


       Suggested literature: Lecture notes
       - Secs.1.2.1-1.2.4,1.7 in [3]
       - Secs. 4.1-4.6 in [4]


       Suggested literature: Lecture notes
       - Secs. 1.2.5,1.8 in [3]
       - Secs. 4.7,4.8 in [4]


       Suggested literature: Lecture notes
       - Sec.22.2 in [3]
• KINEMATICS OF SPECIAL RELATIVITY


Suggested literature: Lecture notes

$\S\S$1-3 in [1]
Sec. 11.1 in [2]
Sec.22.3 in [3]

Lorentz group: Definition. Parity and time reversal transformations. Proper, improper, orthochronous, non-orthochronous Lorentz transformations. General structure of the Lorentz group. Lorentz boosts. Group of proper, orthochronous Lorentz transformations $SO^+(1,3)$.

Suggested literature: Lecture notes

$\S\S$4,5 in [1]
Sec.11.2 in [2]
Sec.22.4 in [3]


Suggested literature: Lecture notes

$\S\S$6,7 in [1]
Secs.11.3,11.4,11.6 in [2]
Secs.22.5.1,22.5.2 in [3]

Matrix representations of the Lorentz group: Rank 2 antisymmetric tensor. Quadratic invariants. Finite dimensional irreducible representations of $SO^+(1,3)$, $O^+(1,3)$ and $O(1,3)$.

Suggested literature: Lecture notes

• COVARIANT FORM OF MAXWELL’S EQUATIONS

First pair of Maxwell’s eqs.: Fields. Field-strength tensor. Covariant form(s) of the first pair of Maxwell’s eqs.

Suggested literature: Lecture notes

$\S\S$23-26 in [1]
Secs.11.9,11.10 in [2]


Suggested literature: Lecture notes

$\S\S$23-25 in [1]
Secs.1.3,1.4,5.1-5.3,5.15,6.1,6.11,6.12 in [2]
Secs.1.4.2,1.2.2 in [3]

Second pair of Maxwell’s eqs.: Covariant form. 4-current. The continuity equation.

Suggested literature: Lecture notes

$\S\S$28-30 in [1]
Sec.1.5 in [3]


Suggested literature: Lecture notes

Sec.1.9 in [3]
**4-potential**: Definition. Bianchi identity. Maxwell’s equation in terms of the 4-potential. Gauge invariance. Gauge fixing condition. Lorenz gauge.

Suggested literature: Lecture notes
\[\S 18\text{ in }[1]\]
\[\text{Secs.6.2,6.3}\text{ in }[2]\]
\[\text{Secs.15.3}\text{ in }[3]\]

- **VARIATIONAL PRINCIPLE**

  **Poisson’s equation in curvilinear coordinates**: Variational principle for Poisson’s equation. Laplacian in curvilinear coordinates. Orthogonal coordinates.

  Suggested literature: Lecture notes
  \[\S\text{Secs.1.7-1.12}\text{ in }[2]\]


  Suggested literature: Lecture notes
  \[\S\text{Secs.12.7}\text{ in }[2]\]
  \[\text{Secs.13.1,13.2}\text{ in }[4]\]


  Suggested literature: Lecture notes
  \[\S 90\text{ in }[1]\]


  Suggested literature: Lecture notes
  \[\S\text{Secs.12.1}\text{ in }[2]\]
  \[\text{Secs.7.9,7.10}\text{ in }[4]\]

- **CONSERVATION LAWS**

  **Symmetries**: Continuous and discrete symmetries of classical Electrodynamics. Noether’s theorem.

  Suggested literature: Lecture notes
  \[\text{Sec.6.10}\text{ in }[2]\]
  \[\text{Secs.15.1,15.2,24.4.2}\text{ in }[3]\]
  \[\text{Sec.13.7}\text{ in }[4]\]


  Suggested literature: Lecture notes
  \[\S\text{Secs.13.3,13.5,13.6}\text{ in }[4]\]
Applications of Classical Electrodynamics

- MAGNETOSTATICS
  Magnetic multipoles:
  Magnetic force and energy:
  Magnetic matter:

- QUASI-STATIC FIELDS

- ELECTROMAGNETIC WAVES
  Waves in vacuum:
  Waves in simple matter:
  Waves in dispersive matter:

- RETARDATION AND RADIATION