Classical Field Theory and Electrodynamics - Course 432

Recommended texts for Course 432 in Classical Electrodynamics given by Dr. Buttimore

- Classical Electrodynamics, J. David Jackson, Wiley, 1998 (3rd edition) [537.12 K23]
- The Classical Theory of Fields by E. M. Lifshitz and L. D. Landau [530.14 L52]
- Classical Field Theory, Francis E. Low, Wiley, 1997 (1st edition) [530.14 N71]
- Introduction to Electrodynamics, David J. Griffiths, Prentice Hall, 1999 [537.6 M1*1]
- Classical Mechanics, Herbert Goldstein et al., Prentice Hall, 2002 (3rd edition)

Topics will be selected from the following for Course 432 in Classical Field Theory.

1. Lagrangian for a discrete system; Lagrangian density for a field in 1+1 dimensions
2. Hamilton's principle; symmetry and conservation laws, Noether's theorem
3. Variational principle; the conserved current; Galilean and Lorentz invariance
4. Special relativity, tensors; time reversal, space reflection; field transformations
5. Covariant field theory; free scalar field, vector fields, the four-vector potential A_μ
6. Antisymmetric field tensor $F_{\mu\nu}$; charged particle interaction and the Lorentz force
7. Lagrangian density for free vector field; Maxwell's equations for $F_{\mu\nu}$, E and B
8. Field equations with particles; gauge invariance, Lorentz gauge, charge conservation
9. Energy momentum tensor $T^{\mu\nu}$, gauge invariant, conserved, traceless; interactions
10. Symmetric gauge invariant tensor $\Theta^{\mu\nu}$, Maxwell stress tensor for fields E and B
11. Particle and field energy-momentum conservation; field angular momentum $M^{\mu\nu\sigma}$
12. Green functions for Laplacian ∇^2, d'Alembertian $\Box$; Liénard-Wiechert potentials
13. Velocity, acceleration fields for moving charge; scattering, Thomson cross section
14. Acceleration fields $F^{\mu\nu}_{\text{rad}}$ in terms of E, B; the Larmor formula, Liénard's formula
15. Radiation from linear and circular accelerated motion, constant magnetic field
16. Relativistic radiation angular distribution, electric and magnetic radiation fields
17. Comparison of linear and circular motion methods for production of radiation
18. Criteria for importance of radiation damping, decay of radius in a circular orbit
19. Requirement for special relativity and quantum theory in some kinematic regions
20. Review of the relativistic approach in classical field theories and electrodynamics
21. Relation to theories of quantum electrodynamics and quantum chromodynamics

The Context of Electrodynamics

CG	1679	Inverse square law	Robert Hooke
CM	1687	Classical Mechanics	Isaac Newton
ED	1865	Classical Electrodynamics	James Clerk Maxwell
SR	1905	Special Relativity	Albert Einstein
GR	1915	General Relativity	Albert Einstein
QM	1926	Quantum Mechanics	Schrödinger and Heisenberg
RQM	1928	Relativistic Quantum Mechanics	Paul Dirac
QED	1947	Quantum Electrodynamics	Feynman, Schwinger, Tomonaga
WI	1957	Weak Interaction theory	Feynman and Gell-Mann
EW	1967	Electoweak Standard Model	Glashow, Salam, Weinberg
DM	1969	Duality: early string theory	Gabriele Veneziano
QCD	1973	Quantum Chromodynamics	Gross, Politzer, Wilczek
SUSY	1974	Supersymmetry	Wess and Zumino
SUST	1984	Superstring theory	M. Green and J. Schwartz

History of Fundamental Constants

c	1676	Velocity of light	Ole Roemer
G	1687	Gravitational constant	Isaac Newton
π	1706	Archimedes' constant named	William Jones
k	1872	Thermodynamic constant	Ludwig Boltzmann
e	1891	Electron named	George Johnstone Stoney
e	1897	Electron discovered	J. J. Thompson
h	1900	Quantum unit of angular momentum	Max Planck
e	1913	Electron charge evaluated	Robert Millikan