ELECTRODYNAMICS 640 - 343.

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Aims of this course

To build on existing knowledge from second year and to develop a unified approach to the solution of problems in electrostatics, magnetostatics and electromagnetism.

To understand the appropriate mathematical and computational tools necessary to solve these problems and which have applications in many other areas in physics.

To introduce new concepts, such as Gauge Invariance and Special Relativity, in electrodynamics.

Text

Electromagnetic Fields and Waves, P. Lorain, D.P. Corson and F. Lorrain (Freeman, 3rd Edition)

Reference

Classical Electrodynamics, J.D. Jackson (Wiley, 2nd Edition)

Syllabus

(This part covered by Dr. Melatos)

1. **Revision of Maxwell's Equations**
   Coulomb's Law; Gauss' Law; Scalar Potential; Ampere's Law; Dielectrics; Biot-Savart Law; Vector Potential; Magnetic Materials; Faraday's Induction Law; No Free Magnetic Charges; Law of Conservation of charge; Combined Maxwell Equations; Electromagnetic Waves. (LCL 27,28,29 and J. Chaps 1,5,6)

2. **Potentials**
   Scalar Potential; Vector Potential; Gauge Transformations; Retarded Potentials (LCL 18,37 and J. 6.4,6.5)

3. **Electromagnetic Waves**
   Derivation of wave equation from Maxwell Equation; Uniform plane waves in vacuum; plane waves in dielectrics; plane waves in conducting materials; skim depth; Group velocity; Poynting Vector; Energy Density. (LCL 28,29 and J 7.1)

(This part covered by me)

4. **Classical Optics Derived from Maxwell Equations**
   Boundary Conditions; Snell's Law; Fresnel Equations; Brewster Angle; Radiation Pressure; Electromagnetic Momentum (LCL 10.2, 20.8, 30.3, 30.5, 32.2 and J 6.8, 7.3)

5. **Boundary Value Problems**
   Method of Images; Transmissionlines; Waveguides and Cavities; Rectangular Waveguide (LCL 33,34 and J. 8.4,8.5,8.7,8.8); Numerical solutions of Maxwell's Equations

6. **Radiation** Oscillating electric dipole; Oscillating magnetic dipole; Antennas (LCL 37.4, 38 and J. 9.2,9.3,9.4

7. **Special Relativity and Electrodynamics** Brief review od special relativity; Invariance of Electric Charge; Four-Current Density; Four-Diemnsional Operatir; Conservation of Charge; Transformation of $\vec{E}$ and $\vec{B}$; Maxwell Equations; Electromagnetic Field Strength Tensor (LCL 13-18 and J 11.9, 11.10)