PHYSICS HONOURS
ADVANCED ELECTROMAGNETIC THEORY
SEMESTER I, 2009

GENERAL AIMS
(a) To present an advanced formulation of the electromagnetic theory that emphasizes the unity of the electric and magnetic phenomena.
(b) To develop mathematical techniques such as Green’s function, special functions, Fourier methods.
(c) To apply the general formalism to solve a diverse range of problems from electrostatics to electrodynamics.

TEXT
The course will be based mostly on the text: Classical Electrodynamics, by J. D. Jackson (in closed reserve at SciTech Library). Lecture notes will be provided during the course via WebCT.

LECTURE ARRANGEMENTS
The lectures will be given by A/Prof Serdar Kuyucak (Rm 351, A28, Tel 903 65306, email serdar@physics.usyd.edu.au) on Mondays and Wednesdays (2 pm) in Lecture Theater 4.

ASSIGNMENTS & ASSESSMENT
There will be 4 assignments during the semester (about every fortnight). Assessment will be based on a 3-hour open notebook final examination (60 marks) and the assignments (40 marks).

LECTURE CONTENT (weekly)
1. Electrostatics: Coulomb's law, concept of electric field, Gauss's law, electric potential, Poisson and Laplace equations, multipole expansion, electrostatic energy.
2. Boundary value problems in electrostatics: Image charge method, Green function, solution of Laplace equation in rectangular and spherical coordinates.
3. Fields in macroscopic media: Polarizability and electric susceptibility, microscopic basis, field equations and electrostatic energy in dielectric media, boundary-value problems with dielectrics, numerical solutions for arbitrary geometries.
4. Magnetostatics: Magnetic monopoles, Ampere's law, magnetic field and vector potential, multipole expansion, magnetic moment, torque on current distribution, boundary value problems in magnetostatics.
5. Time varying fields: Faraday's law, Maxwell equations, potential form, wave equations, Green function, energy in electromagnetic field, conservation of energy—Poynting’s theorem, Maxwell stress tensor and conservation of momentum.
6. Electromagnetic waves: Plane waves, states of polarization, reflection and refraction at a boundary, waves in dielectric and conducting media, superposition, dispersion relations.
8. Special relativity and E&M: Lorentz transformations, electromagnetic field tensor and covariance of Maxwell equations, field of moving charges.
9. Relativistic dynamics of particles and electromagnetic fields: Lagrangian and Hamiltonian for a charged particle in external EM field, motion in uniform static EM fields, Lagrangian and Hamiltonian for the EM field, covariant forms of the stress tensor and energy-momentum conservation.