2B29 Electromagnetic Theory; 2003/04

ii) Syllabus

(Approximate numbers of lectures in square brackets)

Introduction[5]
Mathematical tools. Brief summary of results from 1B26 course; explicit revision of meaning of electric displacement ***D,*** relation between integral and differential forms of proto-Maxwell equations using Stokes' and Gauss' theorems, electric dipole field.

Magnetic media[4]
Magnetic dipole field from current loop. Magnetisation ***M*** as dipole moment per unit volume**,** magnetic field strength ***H***, magnetic susceptibility χ_m. Diamagnetism, paramagnetism ; ferromagnetism. Ampere's law in magnetic media; differential and integral forms. Continuity conditions for ***B*** and ***H*** (c.f. ***D*** and ***E***). Magnetic energy; forces in magnetic systems (linear media). Magnets; solenoid compared to uniformly magnetised bar; toroid; fluxmeter for ***B*** and ***H***. Simple qualitative description of hysteresis.

Maxwell's equations and e.m. waves in vacuo[6]
Displacement current from continuity equation; generalised Ampere's law. Maxwell's equations in integral and differential form; the wave equation; transverse character of unbounded plane waves; polarisation, e.m. energy, the Poynting vector, Poynting's theorem; e.m. momentum and radiation pressure.

Electromagnetic waves in nonconducting media[4]
Refractive index; reflection and refraction at boundaries between dielectric media, Snell's law, reflection and transmission coefficients, Fresnel's relations, Brewster angle, critical angle, total internal reflection.

Propagation and surface reflection in conducting media[3]
Poor and good conductors; skin depth, reflection at a metal surface; plasma frequency, simple plasma dispersion relation, radio waves and ionosphere.

Waveguides[3]
Maxwell's equations in guides, boundary conditions, rectangular guides; the waveguide equation, TM, TE modes, cutoff wavelength, energy flow.

Emission of electromagnetic radiation[2]
Qualitative description of ***E*** and ***H*** fields around Hertzian dipole in near field. Vector potential ***A*** as link with far field. Definition of retarded time; statement without rigorous derivation of far field expressions for ***E*** and ***H*** with **r** and t. Radiated power.