1 The Maxwell Equations

1. Gauge invariance, current conservation, waves. Near field versus far field, i.e. $r \ll c/\omega$ (what we have studied so far) versus $r \gg c/\omega$ (what we will study).

2 Electrostatics (0th order)

- Gauss Law, Coulomb Law, etc.
- Multipole expansion, cartesian and spherical forms in 3D and 2D.
    1. See exam 2015 problem 1.
    2. Force and torques on multipoles – see exam 2013 problem 2 part b.
- Boundary value problems in estatcs and green functions:
    1. Spherical coordinates, Cylindrical coordinates (no z dependence), Cartesian coordinates. Lots of examples from past exams and SBU comps.
    2. Induced charge distribution σ. Energy and stress for a given charge distribution.
- Dielectrics, Polarization charge, Forces and Stress – See exam 2015 and exam 2013 problem one.
- Forces on Dielectrics
- Images. Charges or lines across reflected across planes. Charges and there images in spheres or lines and images in cylinders. See homework and SBU comps.

3 Magnetostics (1st order)

1. Ampere Law, Biot-Savat, etc.
2. Magetostatics boundary value problems. Two specific cases we studied are $A^z(\rho, \phi)$ (cylinder in a magnetic field) and $A^\phi(r, \theta)$ (spinning charged sphere).
3. Magnetic dipole expansion, forces on dipoles.
4. Magnetic fields in media, and surface currents.
5. Magnetic stress tensor
6. Forces on magnetic objects

4 Quasi statics (2nd order)

1. Faraday Law, Lenz Law etc. Basics of Inductors.
2. Changing magnetic fields making electric fields, induction, energy in magnetic fields. Inductance. Magnetic flux.
3. Displacement current. See SBU comps (two examples) and homework (one example).

5 Waves and conservation laws

1. Energy and momentum and angular conservation in the electromagnetic field.
2. Waves in material, reflection at interfaces, (Snell's law in crystal), waves in metal. Stress in the waves.

6 Important specific problems

1. Dielectric or metalic sphere or cylinder in an electric field
2. Magnetizable sphere or cylinder in a magnetic field
3. Cylindrical shell in a constant magnetic field
4. Vector potential of a line of current. Show that it satisfies coulomb gauge condition.
5. Vector potential of a constant magnetic field. All of these are valid $\boldsymbol{A} = \frac{1}{2}\boldsymbol{r} \times \boldsymbol{B}_o$, or $\boldsymbol{A} = -B_o y\, \widehat{\boldsymbol{x}}$, or $\boldsymbol{A} = B_o x\, \widehat{\boldsymbol{y}}$.
6. A charged spinning sphere.
7. Images in sphere and cylinder, and images involving a grounded plane.