PHYS 224 Course Content F13

I Electric charge, force, field, potential

1 Coulomb’s Law and Electric Field Intensity

Properties of Electric Charges
Charging Objects by Induction
**Coulomb's Law** (also 3D problem)
**The Electric Field** (also 3D problem)
Electric Field Lines
Electric potential and finding E from V
Electric Dipole
Force between red blood cells

2 Electric Field of Continuous Charge Distributions

E due to Various distributions (line, ring, disk, plane
Motion of a Charged Particle in a Uniform Electric Field
Oscilloscope

3 Electric potential (also 3D problem)

Electric potential energy
Electric potential
Electric potential and field of electric dipole in spherical coordinates
Cell membrane /potential/ions; axon/action potential
Current dipole
Myocardial cells
The heart, depolarization wave, electric dipole, measurement of $\Delta V$ due to dipole

4 Gauss’ Law

Electric flux
Gauss’ Law, spherical, cylindrical and planar symmetries
E associated with myocardial cell
Conductors in electrostatic equilibrium
E of a solid, charged insulating sphere surrounded by a conducting shell

5 Some additional examples involving V and E

Potential inside and outside uniformly charged sphere
Potential inside and outside parallel plate capacitor
Finite line charge, ring, disk
II Capacitance, RC Circuits, Dielectrics

1 Capacitance and Capacitors

Calculate C for parallel plate capacitor, two concentric spherical shells
Calculate C for myocardial cell
Energy stored in Capacitor
Defibrillator
Circuits with capacitors in series, parallel

2 RC Circuits (series)

Charging, discharging
Electric circuit model of pacemaker cell

3 Dielectrics

Polarization, bound and free charge/densities
Polarized rod, sphere
Electric Displacement, susceptibility
Single cell bacteria with sticky dielectric shell
E, D, P and bound charge density for membrane

III Current, Resistance, DC Circuits

Electric Current, current density

1 Ohm’s Law

Resistance of skin versus body

2 Review of DC Circuits

Kirchhoff’s Rules
3-loop problems

IV Magnetic Force, Filed, Induction

1 Magnets, Magnetic Fields and Forces

Magnetic Fields
F=qvxB
Cyclotron
Velocity selector
Mass spectrometer
F=IxB
Monitoring blood flow in open-heart surgery
Torque on current loop, on magnetic dipole
NMR, concepts, relaxation times, gradients MRI

2 Sources of Magnetic Fields

Charged particle in motion
Biot-Savart Law
Straight wire, loop
Forces between two wires
Ampere’s Law
In and around solid wire, solenoid, toroid, Tokamak
Magnetism in matter, paramagnetism, diamagnetism, ferromagnetism
Earth’s magnetic field
Magnetic blood pump
Effects of large magnetic fields on health (ion movement)

3 Magnetic Induction

Magnetic flux
Faraday’s Law
Patient breathing monitor
Faraday’s Law and motional emf
Lenz’s Law
Induced emf and Electric Field
E inside and outside solenoid
Induction and multi-loop problem
Faraday’s disk
Eddy currents
Self inductance
Charging/discharging RL circuits
Very large voltage developed due to self inductance
Magnetic energy density
MRI scanner disaster
Effects of large transient magnetic fields on health (induced currents in brain)