**Physics 212E – Chowdary**
**Classical and Modern Physics**
**January 19, 2005**

# Objectives for Unit I: Electricity and Magnetism

By the end of this unit, students should be able to:

1.0 (Continuing objectives) Relate concepts related to electricity and magnetism to real world situations and discuss various applications of the concepts to practical problems in various fields of science, medicine, and engineering.

1.1 Describe the physical difference between conductors and insulators.

1.2 Describe and distinguish between charging by contact and charging by induction. Explain how to give a net charge (of either sign) to an insulator or a conductor.

1.3 Explain how electric forces and fields interact with matter. Describe electric polarization and use it to explain how matter which is overall neutral can still feel an electrical interaction.

1.4 Calculate the electric force between two point charges using Coulomb's law. For a given configuration of a small number of point charges, calculate the total electric force (magnitude and direction) acting on any chosen charge, due to all the others.

1.5 Use superposition and the expression for the electric field due to a point charge to calculate the total electric field at a given point caused by a small number of point charges.

1.6 Sketch the electric field as a vector field for various configurations of point charges.

1.7 For a charge in a given uniform electric field, calculate the magnitude and direction of the electric force on the charge. Describe the resulting motion.

1.8 From a physical sketch or verbal description of a continuous line, line segment, or arc of charge, be able to set up and evaluate an integral for the calculation of the electric field at a given point $P$.

1.9 Distinguish and correctly use the expressions for the electric field due to the special cases of: an infinite line charge; a uniformly charged disc along the disc axis; a uniformly charged ring along the ring axis; and an infinite plane of charge. Use these and superposition to find the total electric field due to a combination of sources.

1.10 Know that the electric field is zero within the bulk of a conductor in static equilibrium, and that any electric field just outside the conductor is perpendicular to the surface. Relate the charge density on the surfaces of an isolated conductor to the magnitude of the electric field just outside the conductor's surface and sketch the electric field there.

1.11 For a given electric field and a surface, calculate the electric flux through that surface.

1.12 Relate the net flux through a closed surface to the charge enclosed in the volume defined by that surface through Gauss's law. Use Gauss's law to determine the magnitude of the electric field due to highly symmetric charge distributions.

1.13 Describe in your own words the meaning of electric potential and potential difference in two different ways: how they relate to electric field, and how they relate to electrostatic potential energy.

1.14 Calculate potential differences between various points by integrating the electric field over a path between the two points.

1.15 Calculate the electric potential for a system of point charges, using superposition.

1.16 For a series of parallel plates held at various given potentials, determine the electric field in each region.

1.17 Relate current, charge, potential difference, resistance, and resistivity of materials using the definition of current along with Ohm's law.

1.18 Correctly sketch the direction of the magnetic field in the vicinity of bar (dipole) magnets, especially near the North or South poles.

1.19 Calculate cross products using unit vectors, or by the magnitude with the right hand rule.

1.20 Calculate the force (magnitude and direction) acting on moving charges and current-carrying conductors in a magnetic field using the magnetic force law and the right hand rule.

1.21 Relate the velocity, magnetic field strength, and radius of curvature for a particle moving in a uniform magnetic field, starting from Newton's 2nd law and using the magnetic force.

1.22 For a current loop, relate current and area to determine the magnitude of the magnetic moment of the loop, and use a right hand rule to get the direction. Determine the torque on and the magnetic energy of the coil when placed in a uniform magnetic field.

1.23 Determine the magnitude and direction of a magnetic field created by a current segment using the Biot-Savart law and the right-hand rule.

1.24 Distinguish and correctly use the expressions for the magnetic field due to the special cases of: the center of a circular loop or finite arcs of a circular loop; along the entire axis of an arbitrary solenoid; inside and just outside the central region of a very long solenoid; and outside a wire segment or long straight wire. Use these and superposition to find the total magnetic field due to a combination of sources.

1.25 For a given uniform magnetic field and a surface, calculate the magnetic flux.

1.26 Given a situation in which there is a changing magnetic flux, relate the emf (or current if resistance is known) to the properties of the magnetic field and the coil using Faraday's Law.

1.27 Distinguish situations for which there is or is not an induced emf.

1.28 Determine the direction of induced emf, currents, eddy currents, magnetic fields, or forces using Lenz's Law.

1.29 Describe how hysteresis makes magnetic storage (audio cassettes, video tapes, and disk drives) possible, and understand how magnetic media are read using induction.