OBJECTIVES

The four Study Guides for the course refer to the objectives below and tell you the sections of the text to read, and the problems to do, to make sure you have mastered them. The objectives provide a snapshot of all the important concepts you should have mastered by the end of the course.

STUDY GUIDE 1

1. a) State Coulomb's law in symbolic form and define each symbol used in it.
    b) Given a set of two or more point charges at rest at specified locations, calculate the resultant force (a <u>vector</u> quantity) on one charge due to the others.
        (All vector quantities must be expressed either in component form referred to the unit vectors **ijk** or in terms of a magnitude and a direction relative to clearly defined coordinate axes.)

2. Given two points (x_1, y_1) and (x_2, y_2) in the coordinate plane, calculate the unit vector from one point towards the other.

3. a) Relate electric field to electric force.
    b) Calculate the net electric field (a <u>vector</u> quantity) at a specified points due to a set of point charges whose locations are specified.
    c) Determine the acceleration of a charged particle, given the electric field at its location, and vice versa.

4   Determine the motion of a charged particle in a uniform electric field, given the magnitude and direction of the field and the charge, mass, initial position, and initial velocity of the particle. (This will require the calculation of quantities such as force, acceleration, velocity, displacement, and flight time.)

5. Sketch qualitatively the electric field lines associated with:
    a) a single point charge of given polarity;
    b) two or more stationary point charges of given relative magnitudes and polarities;
        Given a field plot, you should be able to estimate the signs and relative magnitudes of the charges involved.

6. Know the following facts about electric fields in and around conductors:
    a) The electric field is zero everywhere inside a conductor.
    b) An excess charge on an isolated conductor resides entirely on its surface.
    c) The electric field just outside a charged conductor is perpendicular to its surface and proportional to the charge density at that point on the surface.
    d) On an irregularly shaped conductor, the surface charge density (and electric field) are greatest at points of high curvature and smallest at points of low curvature.

STUDY GUIDE 2

7. a) Calculate the potential difference between two specified locations in a
        uniform electric field **E**.
    c) Know the equipotential surfaces for a uniform electric field and their
        relationship to the field lines, and be able to pass back and forth between the field
        lines and the corresponding equipotential surfaces.

8. a) Calculate the electrostatic potential at a specified point in space due to one or
        more stationary point charges, given their locations.
    b) Solve electrostatic problems involving work and potential difference.
    c) Employ energy conservation to solve problems involving charged particles
        moving in electrostatic fields.
    d) Understand the equipotential surfaces of a single point charge or a pair of point
        charges, and, more generally, how to determine the electric field lines for a given
        set of such surfaces.

9. a) Define capacitance.
    b) Given a set of capacitors in a series-parallel configuration and connected to a
        voltage source:
        i)   calculate the equivalent capacitance of the set;
        ii) explain how charge is distributed among the capacitors;
        iii) calculate the charge stored on each capacitor, the potential drop across
             each, and the electrostatic energy stored in each.

STUDY GUIDE 3

10. a) Define electric current, electric current density, resistance, and resistivity.
     b) Understand the interrelationship between the previous quantities and be able to
         determine some given the others.
     c) Know how to relate the potential difference and electric field in a circuit to the
         quantities mentioned in a).
     d) Calculate the power dissipated by a resistor carrying a current.

11. a) Define emf, know its units, and know about the principal sources of emf.
     b) Given a set of resistors in a series-parallel configuration, calculate the equivalent
     resistance of the set.
     c) Given a circuit with resistors and sources of emf:
         i)   calculate the current and power supplied by each source of emf;
         ii) calculate the current through, the potential drop across, and the power
              dissipated in, each resistor.
     d) Solve for the currents, potential differences, and power consumption in
         multiloop circuits using Kirchoff's rules.

12. Know how to calculate the cross product of two vectors in two different ways:
         i)   figure out its magnitude in terms of the magnitudes and relative orientation of
              the two vectors and its direction using the right hand rule.
         ii) determine the Cartesian components of the product in terms of the components
              of the original vectors.

13. a) Given the charge, mass, and velocity of a particle traveling through a uniform magnetic field, be able to determine the (vector) force acting on it by both the methods described in 12).
    b) Given the current in a straight wire located in a uniform magnetic field, know how to calculate the (vector) force experienced by the wire.

STUDY GUIDE 4

14. a) Understand the circular and helical motion of a charged particle in a uniform magnetic field.
    b) Understand the working of the mass spectrometer and the velocity selector.

15. Understand the Biot-Savart law and know how to use it to:
    a) calculate the magnetic field produced at any point in space by a current element
    b) calculate the magnetic field at any point due to an infinitely long current carrying wire
    You should also know how to calculate the field due to a number of infinitely long, parallel current carrying wires using the principle of superposition.

16. a) Know how to calculate the force between two parallel conductors carrying currents in the same or opposite directions.
    b) Know how to calculate the force on a conductor due to any number of parallel current carrying conductors using the principle of superposition.

17. Know how to calculate the (vector) magnetic field
    a) at any point on the axis of a circular current loop.
    b) at any point inside or outside an ideal solenoid.
    c) due to combinations of straight line and circular current segments.
    You should have an understanding of the magnetic field pattern around a long wire, a circular coil and a pair of circular coils.

18. Know how to calculate the magnetic flux of a uniform magnetic field **B** through a planar area A whose normal lies along the direction of the unit vector **n**.

19. Given a circuit in a magnetic field for which the **B**-field changes with time OR the area of the circuit changes with time OR the orientation of the circuit in the **B**-field changes with time, calculate:
    i)   the flux of **B** intercepted by the circuit as a function of time;
    ii) the emf induced in the circuit;
    iii) the magnitude and direction of current flow in the circuit (assuming its resistance to be known).
    Faraday's Law tells us how to calculate both the magnitude and direction of the induced emf due to a changing magnetic field. Lenz's Law is a principle that allows us to determine the direction of the induced emf only.