OBJECTIVES

The four Study Guides for the course refer to the objectives below and tell you what sections of the text to read, and what problems to do, in order 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 the expression.
   b) Given a set of two or more point charges at rest at specified locations, calculate the resultant force (a vector quantity) on one charge caused by the other charge(s). (All vector quantities must be expressed either in component form with **ijk** unit vectors or in terms of a magnitude and angular orientation relative to well-defined coordinate axes.)

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

3. a) Relate electric field to electric force.
   b) Calculate the net electric field (a vector quantity) at a specified location caused by a set of point charges fixed at given locations.
   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 electric field and the charge, mass, initial position, and initial velocity of the particle. (This will require the calculation of such quantities as force, acceleration, velocity, displacement, and 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) If an isolated conductor carries a charge, the charge 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 greater at points of high curvature and smaller 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 charges and 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 for a single point charge or a pair of point charges, and how the electric field lines may be obtained from them.

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) Given two or more simple geometric shapes made of materials of specified resistivity, compare the resistances of the shapes.
    c) Solve problems involving interrelationships among the quantities resistance, potential difference, current, current density, electric field, and resistivity.
    d) Calculate the power dissipated by a resistor carrying current.

11. a) Define emf, specify its units, and identify 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 problems using Kirchoff's rules.

12. a) Apply the right-hand rule in order to:
       i) determine the direction of the force experienced by a charged particle moving in a magnetic field;
       ii) determine the direction of the vector (or cross) product of two coordinate unit vectors, such as **i** x **j**, etc.
    b) Calculate the vector product of two vectors given in **ijk** notation.

13. a) Given the charge, mass, and velocity of a particle traveling through specified electric and magnetic fields, determine the force and acceleration (both vector quantities) of the particle, and related quantities such as velocity, speed, and location at a later time.
    b) Given the current in a wire located in a given magnetic field, calculate the force experienced by a segment of 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. Use the Biot-Savart law to:
    a) calculate the contribution to the magnetic field at specified points produced by a current element, given the current, location, and orientation of the element;
    b) calculate the magnetic field at any point due to an infinitely long current carrying wire.
    c) You should also know how to calculate the field due to a number of infinitely long and 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 along 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.

18. Know how to calculate the magnetic flux of a uniform field **B** through a planar area A whose normal lies along 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 the resistance is known).

    The magnitude of the induced emf is said to be determined by Faraday's Law, and its polarity by Lenz's Law.