UNIVERSITY OF SHEFFIELD
Department of Electronic and Electrical Engineering

EEE220 ELECTRIC AND MAGNETIC FIELDS SYLLABUS GUIDE

JLW 2006

You must be able to…

GENERAL

- Show, where appropriate, the following units:-
  - Charge Q
  - Force N
  - Electric Field Vm^{-1}
  - Electric Potential V
  - Capacitance F
  - Inductance H
  - Energy J
  - Power W
  - Magnetic Flux density (B-Field) T
  - Magnetic Field intensity (H-Field) Am^{-1}
- Use arguments of symmetry to simplify problems

GENERAL - VECTORS

- Apply Pythagoras' Theorem to find the magnitude of a vector
- Resolve a vector into orthogonal components
- Normalise a vector to form a unit vector
- Express a calculated force as a 3D vector
- Recall and apply the right-hand rule or corkscrew rule for determining the direction of a vector formed by a cross-product
- Use superposition to combine forces

ELECTRIC FIELDS

- Recall that opposite charges attract, like charges repel
- Recall the make-up of an electric dipole
- Recall that the total electric field inside a perfect conductor is zero

- Recall that a charged sphere can be approximated by a point source for field calculations outside the sphere.
- Show the field lines for an arbitrary geometry which may include one or more of the following charges:- point, line, and sheet
- Use superposition to find the total electric field due to multiple charges
- State and explain the equilibrium positions of charged beads which are free to move along a line, or around a ring

- Select and use the appropriate equation (given on the formula sheet) for calculating…
  - Electric Field due to a Point charge
  - Electric Field due to a Line of charge
  - Electric Field due to a Sheet of charge
  - Electric Field due to a Sphere of charge
  - Force between two point charges
  - Force on a charge due to the electric field

- Without using Gauss' Law, derive the equation for the electric field due to…
  - A ring of charge
  - A semi-circle of charge (at the centre)

ELECTRIC POTENTIAL

- Recall that the work done in moving a charge between two points in an electric field (and hence the potential difference) is independent of the path taken.
- Show the lines of equipotential for an arbitrary geometry which may include one or more of the following charge distributions:- point, line, and sheet
- Use superposition to find the total Electric Potential due to multiple charges

- Select and use the appropriate equation (given on the formula sheet) for calculating…
  - Potential difference between two points in an arbitrary electric field by integrating E along a path
  - Electric Potential due to a point charge
  - Electric Field by differentiating the electric potential

- Derive the equation for the Electric Potential due to a…
  - (infinitely) long charged wire
  - A ring of charge

CAPACITANCE

- Derive the equation for the capacitance per unit length for a coaxial line
- Derive the equation for the capacitance of a plate capacitor (which may be modified to have two dielectrics etc.)

- Select and use the appropriate equation (given on formula sheet) for calculating…
  - Capacitance of a plate capacitor
  - Energy stored in a capacitor

- Capacitance of capacitors in parallel

ELECTRIC FLUX

- Using Gauss' Law, derive the equation for the electric field due to a…
  - Charged sphere
  - Long Charged wire
  - Infinite charged sheet

MAGNETIC FIELDS

- Apply the Biot-Savart Law to simple geometries to calculate values for the magnetic field
- Use superposition to find the magnetic field due to multiple current carrying conductors
- Use Ampère's Law to show the magnetic field distribution inside and outside an infinitely long solenoid

- Select and use the appropriate equation (given on the formula sheet) for calculating…
  - Magnetic Field due to a long straight current carrying wire
  - Magnetic Field inside a long straight solenoid
  - Line integral of magnetic field for a closed loop surrounding a current carrier

- Use the Biot-Savart Law to derive the equation for the magnetic field due to …
  - An infinitely long straight current carrying wire (*)
  - A finite straight current carrying wire (*)

- A current carrying loop (on-axis solution only)
- An N-turn current carrying loop (on-axis solution only)

(* where necessary, appropriate standard integrals would be given)

- Use Ampère's Law to derive the equation for…
  - Magnetic field inside and outside a long straight current carrying wire

MAGNETIC INDUCTION

- Derive the equation for the…
  - Mutual inductance between two co-axial loops

- Select and use the appropriate equation (given on the formula sheet) for calculating…
  - Inductance of a solenoid
  - Induced emf due to a changing magnetic flux
  - Energy stored in an inductance

MAGNETIC FORCES

- Derive the equation for the…
  - Force on a current carrying wire in a magnetic field

- Select and use the appropriate equation (given on formula sheet) for calculating…
  - Force on a charge moving through a magnetic field
  - Force on a current carrying wire in a magnetic field
  - Force between two current carrying wires