ELEC 318 -- Course Objectives/Proficiencies

Lecture 3
-- to add and subtract vectors and vector fields
-- to form position and distance vectors
-- to multiply vectors using the cross product & dot product
-- to determine the scalar & vector projection of one vector in the direction of another
-- to calculate the angle between two vectors (using the dot product or cross product)
-- to differentiate between Cartesian, cylindrical, and spherical coordinate systems
-- to convert location in one coordinate system to another (Cartesian, cylindrical, spherical)
-- to convert vectors in one coordinate system to another (Cartesian, cylindrical, spherical)
-- to sketch vectors and vector fields (in 2 dimensions) in any coordinate system
-- for a given (non-unit) vector, to determine its magnitude and its direction (unit vector)
-- to perform vector arithmetic (addition, subtraction, multiplication) in any coordinate system
-- to identify a constant-coordinate surface
-- to write the equation of a plane/surface
-- to determine the angle between two vectors in any coordinate system
-- to determine a vector parallel to a line in any coordinate system
-- to find a vector tangential/normal to a surface (e.g. plane, cylinder) in any coordinate system
-- to identify planar, cylindrical, and spherical symmetry
-- to write differential length/area/volume in any coordinate system
-- to perform line/surface/volume integrals in any coordinate system
-- to calculate the circulation of a vector field around any path, in any coordinate system
-- to calculate the flux of a vector field across any bound surface
-- to calculate or estimate the gradient of a scalar field, in any coordinate system
-- to calculate or estimate the divergence or the curl of a vector field, in any coordinate system
-- to use Stoke's Theorem to convert a closed line integral to a surface integral
-- to use the Divergence Theorem to convert a closed surface integral to a volume integral
-- to calculate the Laplacian of a scalar field, in any coordinate system
-- to determine if a field is irrotational/conservative
-- to determine if a field is solenoidal/divergenceless
-- to represent cross product and curl using a matrix determinant

Lecture 4
-- to write Maxwell's Equations for electrostatic fields
-- to calculate total charge given a line/surface/charge density and a given line/surface/volume
-- to calculate the force on a charge (or collection of charges) given electric field intensity
-- to write Coulomb's Law (for discrete or continuous charge distributions)
-- to use Coulomb's Law to determine electric field intensity for discrete charge distributions
-- to use Coulomb's Law to determine electric field intensity for line, surface, & volume charges
-- to solve for electric flux density given electric field intensity, and vice versa
-- to solve for electric flux, given an electric flux density field and a surface in space

ELEC 318 -- Course Objectives/Proficiencies

-- to write Gauss' Law for electric fields
-- to use Gauss' Law to determine electric field intensity for symmetric charge distributions
-- to solve for electric potential from electric field intensity, and vice versa
-- to calculate absolute (scalar) electric potential, given a discrete/continuous charge distribution
-- to calculate the potential difference between any two points in space
-- to use electric potential to determine the work done in moving charges between positions
-- to use the properties of conservative fields to calculate work done along different paths
-- to sketch the electric flux density associated with an electric dipole
-- to calculate the electrostatic energy stored in a discrete/continuous charge distribution
-- to calculate convection and/or conduction current
-- to determine electric field intensity & flux density on either side of a material boundary
-- to memorize that the electrostatic field inside a perfect conductor is zero
-- to solve for polarization (field) and electric flux density, given field intensity and permittivity
-- to differentiate between permittivity and relative permittivity
-- to write Laplace's or Poisson's Equation
-- to determine electric potential as a function of space (1 dimension) using Laplace's Equation
-- to calculate the resistance of a conductor with a uniform or non-uniform cross-sectional area
-- to calculate the capacitance of a dielectric or combination of dielectrics, of arbitrary geometry
-- to use the Image Method to determine **E** or *V* for a charge distribution near a ground plane
-- to use linear superposition to solve for **E** or **D** for any combination of charge distributions
-- to choose between Coulomb's Law, Gauss' Law, & scalar potential to solve for **E** efficiently

<u>Lecture 5</u>
-- to write Maxwell's Equations for magnetostatic fields
-- to write the Biot-Savart Law (for line/surface/volume currents)
-- to use the Biot-Savart Law to determine magnetic field intensity for current distributions
-- to use Ampere's Law to determine magnetic field intensity for symmetric current distributions
-- to solve for magnetic flux density given magnetic field intensity, and vice versa
-- to solve for magnetic flux, given a magnetic flux density field and a surface in space
-- to calculate the force on a moving charge or a current-carrying wire due to a magnetic field
-- to use the Lorentz force equation to calculate force on charge in the presence of both **E** and **H**
-- to calculate the magnetic dipole moment of a current-carrying wire in any orientation
-- to determine the torque experienced by a current-carrying loop using magnetic moment
-- to sketch the magnetic flux density associated with a magnetic dipole
-- to explain magnetization using the concepts of magnetic moment and electron orbit
-- to solve for magnetization and magnetic flux density, given field intensity and permeability
-- to differentiate between permeability and relative permeability
-- to determine magnetic field intensity & flux density on either side of a material boundary
-- to calculate the self-inductance of an arbitrary current-carrying, magnetic geometry
-- to calculate mutual inductance between two inductive geometries

-- to calculate the magnetostatic energy stored in a current distribution
-- to use linear superposition to solve for **H** or **B** for any combination of current distributions
-- to choose between Biot-Savart, Ampere's Law, & vector potential to solve for **H** efficiently

<u>Lecture 6</u>
-- to write Faraday's Law (for time-varying or static fields)
-- to calculate transformer and/or motional electromotive force using Faraday's Law
-- to determine the direction of induced current or induced EMF using Lenz's Law
-- to differentiate between transformer and motional electromotive force
-- to explain the operation of a transformer using Faraday's Law and boundary conditions
-- to solve for voltage/current, stepped up/down, using the ideal transformer equation
-- to differentiate between convection, conduction, and displacement current
-- to write Maxwell's Equations in full (time-varying) form, in the time domain or phasor domain
-- to solve for displacement current using Ampere's Law in full (time-varying) form
-- to convert time-harmonic field expressions between the time domain and the phasor domain
-- to perform vector operations (e.g. curl, divergence) on phasor forms of **E** and **H**

<u>Lecture 7</u>
-- to derive a wave solution for **E** or **H** from a combination of Ampere's & Faraday's Laws
-- to identify and/or calculate amplitude, phase, frequency, angular frequency, period, wave-number, and wavelength from a time-domain expression for a propagating wave
-- to differentiate between free space, lossless dielectrics, lossy dielectrics, and conductors
-- to calculate intrinsic impedance, loss tangent, and skin depth for a given material medium
-- to write **H** from **E** and vice versa, using vector calculus and/or intrinsic impedance
-- to determine direction of propagation and power density using the Poynting vector
-- to sketch **E** or **H** for a propagating plane/cylindrical/spherical wave

-- to define the following terms:

scalar, vector, field, unit vector, position vector, distance vector, dot product, cross product, scalar/vector projection, differential length/area/volume, contour, line/surface/volume integral, planar/cylindrical/spherical symmetry, circulation, flux, net outward flux, flux line, del operator, gradient, divergence, curl, Laplacian, irrotational/conservative, solenoidal/divergenceless, static field, force, Newton, charge, Coulomb, discrete charges, continuous charge distribution, charge density, line/surface/volume charge, finite/infinite distribution, (linear) superposition, electric field intensity, electric flux density, permittivity, charge enclosed, electric dipole, work, Joule, electric (scalar) potential, Volt, relative potential, absolute potential, current, Ampere, current density, free charge, convection/conduction current, velocity of a charge, drift velocity, conductor, conductivity, conductance, Siemens, resistivity, resistance, Ohms, uniform/non-uniform cross section, dielectric/insulator, polarization (field), relative permittivity, dielectric constant, tangential, normal, boundary conditions, material media, charge-free, capacitance & capacitor, Farad, induced charge, parallel plates, coaxial line, electrostatic energy, equipotential surface, Image Method, ground plane, image charge, magnetic field intensity, magnetic flux density, Weber, current distribution, line/surface/volume current, thin filament, solenoid, toroid, bar magnet, permeability, relative permeability, current enclosed, Lorentz force, magnetic dipole, (magnetic) torque, rotation, (magnetic) dipole moment, magnetization, hysteresis, magnetostatic energy, inductance & inductor, Henry, self-inductance, flux linkage, number of turns/loops, magnetic core, mutual inductance, Lenz's Law, electro-motive force, motional EMF, transformer EMF, transformer, displacement current, phasor (form), phase front, plane wave, cylindrical/spherical wave, constitutive parameters, waves & wave equation, propagation, velocity of a wave, amplitude, phase, frequency, angular frequency, period, wave number, wavelength, intrinsic/wave impedance, loss tangent, skin depth, free space, lossy & lossless, Poynting vector, power density