General Course Description: This is an intermediate course in electromagnetism which includes the study of electric fields and potentials, electric current and magnetic fields, solutions to Maxwell's equations, plane waves, propagation in media, refraction, and dispersion.

Catalog Course Description: Electrostatic potentials and fields in vacuum and dielectric media, magnetic vector potentials and fields in vacuum and magnetic materials, electrostatic and magnetic energies, slowly varying currents

- Use and translate between 'curved' coordinate systems (cylindrical and spherical) and Cartesian coordinate systems (for vectors, differential operators, integrals)
- Compute and interpret: gradient, divergence, curl, and Laplacian
- Evaluate line, surface, and volume integrals
- Apply the fundamental theorem for divergences (Gauss Theorem) in specific situations
- Apply the fundamental theorem for curls (Stokes Theorem) in specific situations
- Apply Coulombs Law and superposition principle to calculate electric field due to a continuous and/or discrete charge distributions (e.g., uniformly charged line segment, circular or square loop, sphere, etc.)
- Apply Gauss Law to compute electric field due to symmetric charge distributions
- Give a conceptual description of electric potential and its relationship to energy.
- Explain how conductors shield electric fields, and describe the consequences of this fact in particular physical problems (e.g., conductors with cavities).
- Compute the electric potential of a localized charge distribution
- Calculate electric field from electric potential and vice versa
- Use method of images to determine the potential in a region
- Solve Laplaces equation to determine the potential in a region given the potential or charge distribution at the boundary (Cartesian, spherical and cylindrical coordinates)
- Explain when separation of variables is applicable, and identify what coordinate system is appropriate.
- Use multipole expansion to determine the leading contribution to the potential at large distances from a charge distribution
- Define polarization (P) and electric displacement (D)
- Find the location and amount of all bound charges in a dielectric material
- Evaluate/apply the appropriate boundary conditions for the electric fields and electric potential at the boundaries of materials.
- Calculate the electric energy based on charge configuration

- Calculate the electric energy based on field configuration
- Apply the Lorentz force to motion of charged particles
- Apply Biot-Savart Law and Amperes Law to compute magnetic field due to a current distribution
- Calculate magnetic field from the vector potential
- Apply gauge invariance to the vector potential
- Compute vector potential of a localized current distribution using multipole expansion
- Correctly apply the magnetic scalar potential in appropriate situations
- Calculate the magnetic dipole moment of a current loop
- Calculate forces/torques on magnetic dipoles and current loops
- Define magnetization (M) magnetic intensity (H)
- Find the location and amount of all bound currents in magnetized material
- Evaluate/apply the appropriate boundary conditions for the magnetic fields at the boundaries of surfaces.
- Calculate the induced EMF
- Use Lenzs law to predict which way the current/EMF will be
- Calculate (at least in theory) inductance (L) and know what it depends on
- Calculate the magnetic energy based on current configuration
- Calculate the magnetic energy based on field configuration
- Determine the total resistance or conductivity of a material, calculate the total current flowing, and apply Ohms Law ($J = \sigma E$) to relate the current density to the electric field.
- Solve complex AC circuits with linear components (LRC) via Kirchhoff's laws.
- Explain, write down and apply the full set of Maxwells Equations in differential form, including using them to determine induced electric and magnetic fields.
- Explain, write down and apply the Poynting vector to problems on energy flow
- Calculate the properties of light propagation in and between different media