Electromagnetism

1. **Course number and name:** 020EMENI3 Electromagnetism

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours

3. **Name(s) of instructor(s) or course coordinator(s):** Pascale Abboud, Alfred Hayek, Elias Mechref, Adnan Naja, Antoine El Choueiry

4. **Instructional materials:** course handouts, PowerPoint slides, in-class problems

5. **Specific course information**
   a. **Catalog description:**
   This course begins with a distinct examination of the stationary electric and magnetic fields. Geometrical symmetries are used to benefit from the properties of vector field flux and circulation. Stationary local equations are introduced as a special case of Maxwell equations. Following the presentation of the Maxwell equations and the electromagnetic (EM) energy, attention is focused on the propagation of EM waves in vacuum.

   b. **Prerequisites:** 020SPHNI1 Physical Signals and 020ANGNI1 General Analysis

   c. **Required/Selected Elective/Open Elective:** Required

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
      - Express the electrostatic field and the potential created by a discrete distribution of charges.
      - Exploit the symmetries and invariances of a distribution of charges to characterize the electrostatic field created.
      - Determine a potential difference by circulation of the electrostatic field in simple cases.
      - Establish the expressions for the electrostatic fields created at any point in space by a sphere uniformly charged in volume, by an infinite cylinder uniformly charged in volume and by an infinite plane uniformly charged on the surface.
      - Establish and quote the expression for the capacitance of a plane capacitor in a vacuum.
      - Relate the current intensity to the flux of the volume current density vector.
      - Exploit the properties of invariance and symmetry of the sources and properties of the field created.
      - Establish the expressions for the magnetostatic fields created at any point in space by an infinite rectilinear wire of non-zero cross-section, traversed by currents uniformly distributed in volume, by an infinite solenoid, assuming

  that the field is zero on the outside.
- Establish the local equation for the conservation of charge in Cartesian coordinates in the one-dimensional case.
- Associate the Maxwell-Faraday equation with Faraday's law.
- Cite, use and interpret Maxwell's equations in integral form.
- Make a qualitative association between the space-time coupling between electric and magnetic fields and the propagation phenomenon. Check the consistency of Maxwell's equations with the local conservation of charge equation.
- Derive the propagation equations from Maxwell's equations.
- Establish the Poisson and Laplace equations of electrostatics.
- Describe the structure of a plane wave and a travelling plane wave in a space devoid of charge and current.

b. PI addressed by the course:

PI	1.2	1.3	7.1
Covered	x	x	x
Assessed	x	x	

7. Brief list of topics to be covered

- Electric charge, Field created by a point charge, Field created by a distribution of charges, Topography of the field, Symmetry properties (4 Lectures)
- Field flow and electrostatic potential, Field flow and Gauss's theorem (5 Lectures)
- Methods of studying fields and potentials: Charged sphere, charged cylinder, charged plane, Surface modelling, planar capacitor (4 Lectures)
- Electric current, Properties of the magnetostatic field, Ampère's theorem, Symmetry properties (4 Lectures)
- Infinite cylinder, Long solenoid (2 Lectures)
- Law of conservation of charge, Electromagnetic field (2 Lectures)
- Maxwell's equation (3 Lectures)
- Electromagnetic field energy, Poynting's vector (2 Lectures)
- Equation of propagation in a vacuum, Monochromatic Travelling Plane Wave, complex notation (4 Lectures)