Magnetic Induction

1. **Course number and name:** 020INMCI2 Magnetic Induction

2. **Credits and contact hours:** 2 ECTS credits, 1x1:15 contact hours

3. **Name(s) of instructor(s) or course coordinator(s):** Rémi Z. DAOU

4. **Instructional materials:**
   Textbook : Physique MPSI/MP2I – Tout-en-un, J'intègre – DUNOD (2ème édition)

5. **Specific course information**
   a. **Catalog description:**
      This course is new for students since they only had a descriptive approach to the magnetic field at high school. It is concerned with everyday applications: compass, electric motor, alternator, transformer, speaker, induction plate, radio frequency identification…. Magnetic flux is introduced and magnetic dipole of a current circuit is generalized to magnet.

   b. **Prerequisites**: None

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

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
      - Use a graphical representation of a vector field to identify areas of uniform field, areas of weak field and the location of sources.
      - Draw magnetic field maps for a straight magnet, a circular coil and a long coil.
      - Describe a device for producing a quasi-uniform magnetic field.
      - Know the orders of magnitude of magnetic fields: in the vicinity of magnets, in an MRI device, in the case of the Earth's magnetic field.
      - Use the symmetry and invariance properties of sources to predict the properties of the field created.
      - Assess the order of magnitude of a magnetic field from the expressions given.
      - Define the magnetic moment associated with a plane current loop.
      - Associate a magnetic moment with a magnet by analogy with a current loop.
      - Give an order of magnitude for the magnetic moment associated with a common magnet.
      - Differentiate between the external magnetic field experienced and the intrinsic magnetic field created by the filiform current.
      - Establish and quote the expression for the resultant of the Laplace forces in the case of a conducting bar placed in a uniform and stationary external magnetic field. Express the power of the Laplace forces.

- Establish and quote the expression for the torque as a function of the external magnetic field and the magnetic moment. Express the power of Laplace's mechanical actions.
- Evaluate the flux of a uniform magnetic field through a surface resting on a closed plane-oriented contour.
- Use Lenz's Law to predict or interpret observed physical phenomena.
- Use Faraday's law, specifying the algebraizing conventions.
- Differentiate between internal and external flux. Use Lenz's law of moderation. Evaluate and quote the order of magnitude of the self-inductance of a long coil.
- Carry out a power and energy balance in a system where self-induction occurs, using an equivalent electrical diagram.
- Determine the mutual inductance between two coils of the same axis of great length under total influence.
- Name applications in industry or everyday life.
- Establish the system of equations in forced sinusoidal mode using equivalent electrical diagrams.
- Interpret the phenomena observed qualitatively. Write down the electrical and mechanical equations, specifying the sign conventions. Carry out an energy balance.
- Explain the origin of eddy currents and give examples of their uses.

b. PIs addressed by the course:

PI	1.2	1.3
Covered	x	x
Assessed	x	x

7. Brief list of topics to be covered

- The magnetic field - Field maps - Long coil - Symmetry and invariance - Magnetic moment (1 lecture)
- Tutorials (1 lecture)
- Action of a magnetic field - Laplace force - Magnetic torque (2 lectures)
- Tutorials (2 lectures)
- Law of induction - Faraday's law - Exception to Faraday's law (1 lecture)
- Fixed circuit in a variable magnetic field - Self-induction - Self-inductance - Mutual inductance (2 lectures)
- Tutorials (2 lectures)
- Moving circuit in a stationary magnetic field - Generating Laplace rails - Induction braking – Alternator (2 lectures)
- Tutorials (2 lectures)