

Electrotechnics

1. Course number and name: 020ETCES1 Electrotechnics

2. Credits and contact hours: 6 ECTS credits, (2 lectures per week) x 1:15.

3. Instructor's or course coordinator's name: Ragi GHOSN

4. Instructional materials:

a. Professor textbook.

b. References:

- Électrotechnique : R.P. BOUCHARD et G. OLIVIER, 2^o éd., Presses internationales ; Polytechnique, 1999.
- Électrotechnique : T. WILDI, 3^o éd., Éd. De Boeck Université, 2001.
- Principes d'électrotechnique : M. MARTY, D. DIXNEUF et D. GARCIA GILABERT, Dunod, 2005.

c. Other course material: Slides.

5. Specific course information

a. Catalog description:

The aim of this course is the study of three-phase electrical networks in balanced and unbalanced steady-state sinusoidal operation as well as single-phase and three-phase transformers. The course covers the dielectrics, conductors, magnetic materials used in electrotechnics, the operating and modeling of linear and nonlinear magnetic circuits without and with flux leakage and the effect of the airgap.

It also covers the modeling of three-phase balanced and unbalanced electrical networks operating in a sinusoidal regime by the method of the single-phase star equivalent scheme and the symmetrical components method. Finally, the principles of operation of single-phase and three-phase transformers are studied in order to establish their equivalent circuits and predetermine the values of the voltages, currents, powers, efficiency at no-load, short-circuit and load operations.

b. Prerequisites: Linear Electrical Systems and Networks (020SRLNI4) or (020SRLCI4) and Electromagnetism (020EMENI3) or (020EMECI3)

c. Required for EE students.

6. Educational objectives for the course

a. Specific outcomes of instruction:

- Analyze linear and non-linear magnetic circuits, with or without airgap, while neglecting or considering the leakage flux.
- Calculate the total core losses including the eddy currents loss and the hysteresis loss.
- Analyze a three-phase AC electrical balanced circuit operating with sinusoidal waveforms by the method of the Wye equivalent one-phase circuit.
- Analyze a three-phase AC electrical unbalanced circuit operating with sinusoidal waveforms by the symmetrical components method.

- Define an ideal transformer and analyze its operation including impedance scaling. Explain the models of perfectly coupled and imperfectly coupled windings by the partial leakages method and the total leakages method.
- Calculate the coupling factor and the inductive leakage factor or Heyland factor.
- Single phase transformer: Describe the construction – Determine an equivalent circuit in steady-state and calculate the values of its elements using no-load and short-circuit tests – Illustrate the phasor diagram – Predict the voltage drop and the efficiency at load operation – Describe the rated values and the short-circuit impedance – correctly Interpret the data on the transformer nameplate.
- Three phase transformers: Describe the construction – Explain primary and secondary winding connections and the vector group – Determine an equivalent circuit in steady-state and calculate the values of its elements using no-load and short-circuit tests – Illustrate the phasor diagram - Predict the voltage drop and the efficiency at load operation – Describe the rated values and the short-circuit impedance – Interpret correctly the data on the transformer nameplate.

b. PIs addressed by the course.

PI	1.1	1.2	1.3	6.1	6.2	6.3	6.4
Covered	x	x	x	x	x	x	x
Assessed				x	x	x	x
Give Feedback				x	x	x	x

7. Brief list of topics to be covered:

- Course introduction: 1 Lecture
- Electromagnetism reminder, dielectrics, conductors, magnetic materials used in electrotechnics, operating and modeling of linear and non-linear magnetic circuits without and with flux leakage, effect of the airgap: 7 Lectures.
- Problems on magnetic circuits: 3 Lectures.
- Ideal transformer, magnetic coupling, flux leakage modeling, equivalent electric circuits, construction of a single-phase transformer, equivalent circuits, phasor diagram, no-load, short-circuit and load operations, voltage regulation, rated values, nameplate, tests, efficiency: 7 Lectures.
- Problems on single phase transformer: 4 Lectures.
- Reminder on steady-state sinusoidal regime, balanced three-phase regime, wye and delta connections, power calculations and measurements, single-phase star equivalent circuit, unbalanced three-phase regime, symmetrical components method, examples: 7 Lectures.
- Three-phase transformer: Construction of a three-phase transformer, windings connections, wye, delta, zigzag, equivalent circuits, vector group, phasor diagram, no-load, short circuit and load operations, voltage regulation, rated values, nameplate, tests, efficiency: 6 Lectures.
- Problems on three-phase transformers: 3 Lectures.
- Lab sessions on three-phase power measurements, single-phase transformers, three-phase transformers: Four sessions of 3 hours each, equivalent to 4 course lectures.