Optimization

1. **Course number and name:** 020OPTES5 –Optimization

2. **Credits and contact hours:** 4 ECTS credits, (2 lectures per week) x 1:15.

3. **Instructor's or course coordinator's name:** Elie Hleihel

4. **Instructional materials:** Instructor's PowerPoint slides, textbook.

5. **Specific course information**
   a. **Catalog Description:**
   This course introduces optimization techniques tailored for electrical engineers. Students learn to identify electrical engineering problems and formulate them as optimization problems by selecting appropriate objective functions and constraints and applying optimization algorithms to find optimal solutions. Topics include linear and nonlinear optimization, convex optimization, and heuristic methods. Emphasis is placed on understanding mathematical foundations, algorithmic implementations, and practical applications in electrical engineering systems. Besides, students learn to interpret and assess optimization results by comparing different optimization algorithms in terms of convergence speed, computational burden, and ability to find local/global minimum.

   b. **Prerequisites or co-requisites:** None
   c. **Selected Elective** for EE students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - Overview of optimization problems in electrical engineering:
     - Power system optimization.
     - Renewable energy integration.
     - Energy management systems.
     - Electrical machine design.
     - Circuit design and control system optimization.
   - Selection of objective functions and constraints for optimization problems.
   - Classification of optimization problems: linear, nonlinear, convex, non-convex.
   - Application of optimization algorithms to find optimal solutions.
   - Analysis and interpretation of optimization results.

   b. **PI addressed by the course:**

PI	1.1	1.2	1.3	2.1	2.2
Covered	X	X	X	X	X
Assessed					

7. Brief list of topics to be covered:

- Linear programming:
  - Formulation of LP problems.
  - Simplex method.
  - Duality theory and interpretation.
  - Sensitivity analysis.
- Non-linear programming:
  - Gradient-based methods: gradient descent, Newton's method.
  - Constrained optimization: Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions.
  - Convexity and convex optimization.

- Convex Optimization:
  - Convex optimization algorithms: interior-point methods, sub gradient methods.
  - Duality in convex optimization.

- Heuristic Optimization Methods
  - Introduction to metaheuristic optimization techniques.
  - Genetic algorithms (GA), Particle swarm optimization (PSO), Simulated Annealing (SA), and Ant colony optimization (ACO).