Power Generation

1. **Course number and name:** 020PENES4 Power Generation

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

3. **Name(s) of instructor(s) or course coordinator(s):** Chantal Maatouk

4. **Instructional Materials:** PowerPoint slides

   Textbooks/References:

   - Conversion d'énergie par turbomachines. Michel Pluviose. Collection Ellipses.
   - Power generation, operation and control. 3rd edition. Wiley.

5. **Specific course information**

   a. **Catalog description:**

   The Power Generation course is designed to provide students with a deep insight into the various technologies and methodologies used to generate electrical power. It encompasses theoretical principles, practical applications, and the environmental considerations associated with power generation. Specially the steam and gas power cycles. The course will cover the operating conditions of steam and gas cycles at design conditions and partial loads. Economic and environmental aspects are discussed.

   b. **Prerequisite:** Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1).

   c. **Selected Elective** for EE and ME students.

6. **Educational objectives for the course**

   a. **Specific outcomes of instruction:**

   A student who successfully fulfills the course requirements will have demonstrated an ability to:

   - Apply the fundamental principles of thermodynamics to study thermal power plants for power generation from different sources of fossil fuels.
   - Analyze, design, and optimize thermal power plants by applying their knowledge developed on the main mature technologies.
   - Develop mathematical models to design and optimize conventional power generation systems, conduct technical, economic, and environmental analysis, and interpret the results.
   - Prepare students for careers in the energy sector by providing a solid foundation in the principles and practices of power generation across a diverse range of technologies.

b. PI addressed by the course:

PI	1.2	1.3	2.1	2.2	2.4	4.2
Covered	x	x	x	x	x	x
Assessed	x	x	x	x	x	x

7. Brief list of topics to be covered

Course introduction: World energy situation. Energy forecasts and world reserves. Forms of energy and mode of conversion. Power generation by turbomachinery. Economic and environmental aspects. Electricity sector: load curve, annual monotonous curve, (2 lectures).

Fundamentals of Energy Conversion and Heat Transfer: Principles of Heat Generation and Transfer; How can we produce heat? What are the modes of heat transfer? Fundamentals of Thermodynamics; First law, Second law, Carnot cycle. Basic Principles of Fluid Mechanics; mass conservation, Bernoulli equation, Compressible fluids, (4 lectures).

Steam Power Plants: Introduction of the steam power cycles; Carnot cycle, Role of working fluid, Rankine cycle, superheat cycles, supercritical cycles, cycles efficiency. Hirn's Cycle; Theoretical and real. Ideal and real Regenerative Cycle. Reheat Cycle. Condensation of steam. Multi-stage Turbines. Impulse turbines. Reaction turbines. Multiple casing turbine. Non-condensable fluid turbines. Pressure-flow characteristics (10 lectures).

Gas power cycle: Analysis of the ideal and real gas power cycle. Calculation of a gas turbine performance at nominal and partial loads. Improvement; Gas turbines with regeneration, intercooled compression, and reheating (6 lectures).

Combined gas-vapor power cycles: Principle of operation of a combined cycle. Thermodynamic analysis. Recovery boiler. Performance at partial loads, (2 lectures).