Automotive Propulsion Systems

1. **Course number and name:** 020SPAES5 Automotive Propulsion Systems

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

3. **Name(s) of instructor(s) or course coordinator(s):** TBD (To Be Determined)

4. **Instructional Materials:** PowerPoint slides

   Textbooks/References:
   - Vehicle Propulsion Systems, Introduction to Modeling and Optimization, L. Guzzella and A. Sciaretta, 4th edition, Springer. ISBN-10 3-540-25195-2.
   - Design and Control of Automotive Propulsion Systems, Sun Zongxuan and Zhu Guoming, 1st edition, Taylor and Francis. ISBN 9780429094613.

5. **Specific course information**
   a. **Catalog description:**
   This course covers the basics of transmission systems and ground propulsion, energy consumption and the environmental impact of modern means of transport, configuration of conventional vehicle propulsion systems, principles of operation of conventional propulsion systems, technologies of propulsion systems for battery electric vehicles, technologies of propulsion systems of fuel cell vehicles, hybrid electric powertrain technologies, stop/start of hybrid, parallel hybrid and series/parallel hybrid drive systems.

   b. **Prerequisites:** Automobile (020AUTES3) and Thermal Engines (020MOTES4).

   c. **Selected Elective** for 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:
   - Explain the role that engine design features and operating parameters have on engine performance.
   - Identify energy losses and fuel consumption.
   - Evaluate the performance of IC engine, and other alternative hybrid or electric powertrain configurations.
   - Design of propulsion systems for improved performance using engineering analysis.
   - Estimate engine performance using computer simulation.
   - Select electro-mechanical components to meet design objectives.

b. PI addressed by the course:

PI	1.1	1.2	1.3	2.4	2.5	7.1	7.2
Covered	x	x	x	x	x	x	x
Assessed							

7. Brief list of topics to be covered

- **Introduction:** Objectives – Upstream processes – Energy density of on-board energy carriers – Pathways to better fuel economy.
- **Vehicle energy and fuel consumption-Basic concepts:** Vehicle energy losses and performance analysis – Energy demand in driving cycles – Methods and tools.
- **IC-Engine-based propulsion systems:** IC engine models – Gearbox models – Fuel consumption of IC engine power trains.
- **Models of electric and hybrid-electric propulsion system:** Electric propulsion systems – Hybrid-electric propulsion systems – Electric motors – Modeling of generators – Batteries – Supercapacitors – Electric power links – Torque couplers.
- **Models of hybrid-inertial and hybrid-hydraulic propulsion systems:** Short-term storage systems – Flywheels – Continuously variable transmissions – Hydraulic accumulators – Hydraulic pumps/motors.
- **Models of fuel-cell propulsion systems:** Fuel-cell electric vehicles and fuel-cell hybrid vehicles – Fuel cells – Reformers.
- **Case studies:** Gear ratio optimization – IC engine flywheel powertrain – Fuel optimal trajectories of a racing FCEV, etc.