COURSE SYLLABUS
Transmission and alternative drivetrains. Hybrid vehicles
2023-2024

1. Program information

1.1	Higher education institution	*Universitatea Națională de Știință și Tehnologie POLITEHNICA București, Centrul Universitar Pitești*
1.2	Faculty	*Mechanics and Technology*
1.3	Department	*Automobiles and Transport*
1.4	Field of studies	*Automotive Engineering*
1.5	Level of education	*Master*
1.6	Program / Qualification	*Automotive Engineering for Sustainable Mobility*

2. Discipline information

2.1	Name of discipline					*Transmission and alternative drivetrains. Hybrid vehicles*					
2.2	Instructor of the lecture/course activities					*Adrian CLENCI*					
2.3	Instructor of the lab activities					*Adrian CLENCI*					
2.4	Year of the studies	***I***	2.5	Semester	***I***	2.6	Type of evaluation	***E***[1]	2.7	The discipline regime	***O, DAP***[2]

3. Estimated total time

3.1	Number of hours per week	***2***	3.2	lecture	***1***	3.3	lab	***1***
3.4	Total hours of the Academic Syllabus	***28***	3.5	lecture	***14***	3.6	lab	***14***
Distribution of the time allocated to the individual study (= Nb. of credits x 25 – Total hours of the Academic syllabus = 4 x 25 – 28 = 72 hours)								**ore**
Study by handbook, course support, bibliography and notes								***20***
Additional documentation in the library, on specialized electronic platforms and in the field								***20***
Preparation of seminars / laboratories, topics, reports, portfolios, essays								***20***
Tutorial								***8***
Examinations								***4***
Other activities...								

3.7	Total hours of individual study	***72***
3.8	**Total hours per semester** (= 3.4 + 3.7)	***100***
3.9	**Number of credits allocated to the discipline**	***4***

4. Prerequisites (where applicable)

4.1	Curriculum	-
4.2	Skills	*Mathematics, Physics, Mechanics, Numerical methods, Electrotechnics, Electronics and automatic systems, Vehicle dynamics, Thermodynamics, Automobile's construction, Internal Combustion Engine, Fuel economy and environment protection, Testing and homologation*

5. Conditions (where applicable)

5.1	for the lecture/course	*Classroom equipped with board, video projector, projection screen, computer*
5.2	for the lab	*Board, computer, lab equipments, test bench*

6. Course goal(s)

6.1 The main goal of the discipline	*Development of competences in the field of Automotive Engineering by transmitting to the students the notions related to alternative drivetrains*
6.2 Specific goal(s)	*At the end of this course, the student should be able to discuss on this particular subject: the architecture of the classic, hybrid, and electric drivetrain*

[1] *E – Exam*
[2] *O – compulsory; DAP – deepening discipline*

7. Contents

7.1. Lecture/course		No. of hours	Teaching methods	Remarks Resources used
1	The automobile's evolution. General layout of the automobile. Automobile's performance: power, torque, consumption, pollution, driveability, reliability. Well-to-wheel vs. Tank-to-wheel vs. total life cycle analysis. Legislative regulations regarding chemical pollution and CO_2 emission vs. client expectation	1	*Lecture* *Exposure with support material* *Explanation* *Description and exemplification* *The heuristic conversation* *Debating* *Case study*	*Board, sketches, tables, graphs, sheets, photos, models, video projector, computer, internet*
2	The automobile's use. Longitudinal vehicle dynamics: balance of forces while driving. Effect of vehicle parameters on the energy balance (effects of mass, rolling, aerodynamics). Regenerative braking: energy recovery during braking	2		
3	The internal combustion engine vehicle (ICEV): - the internal combustion engine and fuel storage (principles of operation and output characteristics) - the transmission as an interface between the energy source (the internal combustion engine or the electric motor) and the driving wheels (the energy's user): why does ICEV needs a transmission/gearbox; discrete and non-discrete (continuous) variation of transmission ratio with and without power interruption; manual and automatic gearshift vs. automatic torque and speed conversion	4		
4	The battery electric vehicle (BEV): - electric machines and electrical storage: principles of operation and output characteristics - the transmission as an interface between the energy source (the internal combustion engine or the electric motor) and the driving wheels (the energy's user): why does BEV uses a transmission/gearbox	3		
5	The hybrid electric vehicles (HEV): - serial hybridization - parallel hybridization - serial-parallel hybridization - power-split hybridization	4		
	TOTAL HOURS	**14**		

7.2. Lab		No. hours	Teaching methods	Remarks Resources used
1	Engine test bench vs. Roller test bench (chassis dyno) vs. Real Driving Emissions (RDE) via Portable Emissions Measurement Systems (PEMS)	4	*Exposure with support material* *Explanation* *Description and exemplification* *The heuristic conversation* *Debating* *Case study* *Exercising* *Experiment*	*board, sketches, graphs, photos, models, computer, internet, lab equipment video projector*
2	Simulation at the internal combustion engine test bench of the steady movement of a passenger car on the road. Various experimental determinations for this situation and post-processing of the experimental data to outline the energetic and ecologic performance according to speed and load.	4		
3	Hardware-in-the-Loop (HiL): virtual testing	2		
4	Architecture of a hybrid driveline test bench	2		
5	Lab ending. Student grading for lab activity	2		
	TOTAL HOURS	**14**		

Minimal bibliography:

François Badin – Hybrid vehicles, IFP Energies nouvelles Publicatios, Editions Technip, Paris, 2013
Amtoni Szumanwski – Hybrid electric powertrain. Engineering and Technology, IGI Global, USA, 2013
Douglas R. Carroll – Energy efficiency of vehicles, SAE International, USA, 2020
Reza N. Jazar – Vehicle Dynamics. Tehory and Application, Springer, 2008
Rajezsh Rajamani – Vehicle Dynamics and control, Springer, 2006
Stephan Rinderkencht, Philippe Jardin, Arved Esser – Future powertrain technologies, MDPI, 2020
David A. Crolla – Automotive engineering: powertrain, chassis system and vehicle body, Elsevier, 2009
H. Naunheimer, B. Bertsche, J. Ryborz, W. Novak – Automotive transmissions. Fundamentals, selection, design and application, Springer, 2011
A.J. Martyr, M.A. Plint – Engine testing, Elsevier, 2007
Lino Guzzella, Antonio Sciarretta – Vehicle propulsion systems. Introduction to modeling and optimization, Springer, 2005
B.T. Fijalkowski – Automotive mechatronics: operational and practical issues, Springer, 2011

8. Corroboration the contents of the discipline with the expectations of the epistemic community representatives, professional associations and employers in the field related to the program

The skills acquired in this discipline allow the graduates to work in the field of automotive engineering: design, calibration, test, validation, and homologation of passenger hybrid cars. Being a specialized discipline, its purpose is training the students, especially for engineering centers (design, research, development, innovation).

9. Evaluation

Activity type	10.1 Evaluation Criteria	10.2 Evaluation methods	10.3 Percentage of the final grade
10.4 Course	Active involvement during the lectures	Questions / answers. Weekly recording	10%
	Good understanding of the treated subjects and the ability to analyze and synthesize	Written and oral exam	50%
10.5 Lab	Active involvement during the activity throughout the semester	Questions / answers. Individual discussions. Weekly recording	20%
10.6. Homework	Correct resolution. Quality of presentation	Oral presentation. Individual discussions	20%
10.7 Minimum standard of performance	• handling of the units of measure involved in the specific parameters of the course • knowledge of the architecture of the classic, hybrid and electric drivetrains		

Date (of filling)	Instructor (lecture/course)	Instructor (lab)
28.09.2023	**Adrian CLENCI**, Professor	**Adrian CLENCI**, Professor
Date (of approval)	Director of supplying department	Director of beneficiary department
29.09.2023	**Helene ȘUSTER**, ș.l.	**Helene ȘUSTER**, ș.l.