COURSE SYLLABUS
Engine Calibration
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					*Engine Calibration*					
2.2	Instructor of the lecture/course activities					*Mihai NICULAE*					
2.3	Instructor of the lab activities					*Mihai NICULAE*					
2.4	Year of the studies	***II***	2.5	Semester	***I***	2.6	Type of evaluation	***E***[1]	2.7	The discipline regime	***O, DSI***[2]

3. Estimated total time

3.1	Number of hours per week	***3***	3.2	lecture	***2***	3.3	lab	***1***
3.4	Total hours of the Academic Syllabus	***42***	3.5	lecture	***28***	3.6	lab	***14***
Distribution of the time allocated to the individual study (= 3.9 x 25 - 3.4 = 5 x 25 – 42 = 83 hours)								**ore**
Study by handbook, course support, bibliography and notes								***25***
Additional documentation in the library, on specialized electronic platforms and in the field								***25***
Preparation of seminars / laboratories, topics, reports, portfolios, essays								***30***
Tutorial								***-***
Examinations								***3***
Other activities...								

3.7	Total hours of individual study	***83***
3.8	**Total hours per semester** (= 3.4 + 3.7)	***125***
3.9	**Number of credits allocated to the discipline**	***5***

4. Prerequisites (where applicable)

4.1	Curriculum	-
4.2	Skills	*Mathematics, Chemistry, Physics, Mechanics, Numerical methods, Vehicle dynamics, Thermodynamics, Electronics and automatic systems, Automobile's construction*

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 the engine calibration (ignition, injection, turbo, EGR, exhaust after-treatment)*
6.2 Specific goal(s)	*At the end of this course, the student should be able to discuss on this particular subject: the structure of an automatic system (sensors-ECU-actuators), listing the sensors and actuators used for the engine control, the main types of control (PWM, PID, closed and open loop), the main strategies used to control the AFR, the ignition, the boost pressure and exhaust aftertreatment.*

[1] *E – Exam*
[2] *O – compulsory; DSI – synthesis discipline*

7. Contents

7.1. Lecture/course		No. of hours	Teaching methods	Remarks Resources used
1	Internal combustion engine. Evolution. Various qualities/performance: power-torque, consumption, pollution, driveability, reliability. Various compromises. Legislative regulations regarding chemical pollution and CO_2 emission. Engine test bench vs. Roller test bench (chassis dyno) vs. Real Driving Emissions (RDE) via Portable Emissions Measurement Systems (PEMS)	6	*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	Internal combustion engine seen as an automatic control system: sensors-ECU-actuators structure, open/closed loop control, on-off/PWM control, PID controller, strategy, calibration, mapping, physical sensors vs. virtual sensors, interpolation etc.	6		
3	Spark ignition engine control. Composition of the injection and ignition control system. Sensors (fundamental parameters, correction parameters). Actuators/controls (commands): ignition, fuel pump, injection, idle adjustment. Pollution: qualitative & quantitative lambda probe; TWC; deNOxCat; GPF; closed loop control at $\lambda = 1$ vs. TWC efficiency; catalytic post-treatment at $\lambda \neq 1$; gasoline vapor re-aspiration; EGR control. Various strategies: torque structure (slow loop vs. fast loop), cylinder 1 recognition, cold start, TWC light-off, anti-knocking, “unlooping”, OBD (limp-home) etc. Intersystem links: ECU (injection + ignition) ↔ anti engine starting, engine thermal state/electric fan working regime, deceleration, VVA/VVT, A-C, ESP, Automatic gear box, Assisted steering.	8		
4	Compression ignition engine control. Composition of the injection control system. Sensors (fundamental parameters, correction parameters). Actuators/controls (commands): injection (splitting and phasing), air loop (EGR, overcharging), preheating glow plugs. Depollution (DOC, DPF, NOxTrap, SCR). Various strategies: torque structure, cold starting, noise reduction caused by self-ignition, DOC light-off, regeneration of DPF (active / passive), OBD etc. Intersystem links: ECU (injection + ignition) ↔ anti engine starting, engine thermal state/electric fan working regime, passenger compartment heating, deceleration, A-C, ESP, Automatic gear box, Assisted steering.	8		
	TOTAL HOURS	**28**		

7.2. Lab			No. hours	Teaching methods	Remarks Resources used
1	Prerequisites	Electronic ignition and injection management system: identification of all components (sensors, actuators) using different engines; correlation with the aftertreatment systems of engines	2	*Exposure with support material* *Explanation* *Description and exemplification* *The heuristic conversation* *Debating* *Case study* *Exercising* *Experiment* *Computer aided learning*	*board, sketches, graphs, photos, models, computer, internet, lab equipment video projector*
		Simulation at the engine test bench of the steady movement of a passenger car on the road. Various experimental determinations for this situation: indicating diagram, hourly fuel consumption, λ and pollutant emissions before and after TWC, measuring the temperature of exhaust gases at various points, upstream of TWC. Post-processing of experimental data to obtain the following: CoV, imep, bmep, p', HR, RoHR, isfc, bsfc, ηi, ηe, ηm, $mc_{(cc)}$, $ma_{(cc)}$, C_{fp}, C_{0fp}, η_u	4		
2	Spark advance sweeping, knocking (kp-pk) and experimental data post-processing		2		
3	Strategies for the fast TWC light-off (monitoring the temperature of exhaust gases at various points, upstream of TWC)		2		
4	“Unlooped” operation/enrichment to avoid thermal overload of the exhaust manifold		2		
5	Hardware-in-the-Loop (HiL): virtual testing		2		
		TOTAL HOURS	**14**		

Minimal bibliography:

Clenci, A. – Engine calibration. Course support/notes in PowerPoint form (electronic)
RTR, DE-MC – Engine calibration. Course support in PowerPoint form (electronic)
Heywood, B.J. – Internal Combustion Engine Fundamentals, McGraw-Hill, 1988
Guzella, L., Onder, C.H. – Introduction to modeling and control of internal combustion engine systems. Springer, 2010
Denton, T. - Advanced automotive fault diagnosis, Elsevier, 2006

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, homologation of thermal engines and automobiles. Being a specialized discipline, its purpose is training 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 Good understanding of the treated subjects and the ability to analyze and synthesize	Weekly recording Written and oral exam	10% 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 structure of the automatic control systems • knowledge of the sensors and actuators used to control the engines		

Date (of filling)	Instructor (lecture/course)	Instructor (lab)
28.09.2023	**Mihai NICULAE**, **Dr.**	**Mihai NICULAE**, **Dr.**

Date (of approval)	Director of supplying department	Director of beneficiary department
29.09.2023	**Helene ȘUSTER, Ș.l.dr.**	**Helene ȘUSTER, Ș.l.dr.**