












































Automotive Engineering for Sustainable Mobility (AESM)









Enseignements de 1^{ère} année




Code UE	Intitulé de l'Unité d'Enseignement	Anglais	DDRS	Innov.	Responsable	Total encadré (hors PEA)	ECTS
AUTOMOTIVE ENGINEERING for SUSTAINABLE MOBILITY (AESM)						664	60
1^{ère} année AESM - Semestre 1						347	30
1AE01	Trends in Automotive Transportation and Sustainable Mobility				LE MOYNE L.	10	1
1AE02	Scientific pre-requisite				JABLOUN M.	50	5
1AE03	Electrical engineering					50	5
1AE04	IT: programming				JENNANE R.	50	5
1AE05	Advanced physics				KOURTA A.	50	5
1AE06	French culture and language				BOUTONNE G.	70	4
1EVA1	Evaluation enseignements semestre 1				BECK.K	2	0
Une UE au choix selon option ECM ou VDIV							
1AE07	Vehicle Dynamics 1				HIGELIN P.	65	5
1AE08	Internal combustion engines				HIGELIN P.	65	5
1^{ère} année AESM - Semestre 2						317	30
2AE01	Acquisition systems and signal processing				RAVIER P.	50	5
2AE02	Real Time Programming				CANALS R.	50	5
2AE03	Control and simulation of powertrains				CHARLET A.	35	5
2AE04	Project				HIGELIN P.	130	10
2EVA1	Evaluation enseignements semestre 2				BECK.K	2	0
Une UE au choix selon option ECM ou VDIV							
2AE05	Control and on-board diagnostics applied to internal combustion engines				COLIN G.	50	5
2AE06	Control and on-board diagnostics applied to vehicle dynamics				COLIN G.	50	5


Automotive Engineering for Sustainable Mobility		1AE01	Semester 1						
<div>Trends in Automotive Transportation and sustainable Mobility</div>									
Supervisor: Luis LE MOYNE			ECTS : 1						
<div>Skills</div> <div>At the end of this course, engineering students will be able to:</div> <div><div><div></div><div>Understand transport geo-politics</div></div><div><div></div><div>Understand the inventory of resources</div></div><div><div></div><div>Recognize operational actors in the transport sector</div></div></div>									
<div>Syllabus</div> <div><div><div></div><div>Sustainable mobility</div></div><div><div></div><div>Environmental incentives</div></div><div><div></div><div>Well-to-wheels CO2 analysis</div></div><div><div></div><div>Areas for technology improvements</div></div></div>									
<div>Grading</div> <div>Written exam</div>									
<div>Learning hours</div> <table><tr><td>Lectures 10h00</td><td>Tutorials 0h00</td><td>Lab sessions 0h00</td><td>Free labs 0h00</td><td>Project 0h00</td></tr></table> <div>In person teaching: 10h00</div>					Lectures 10h00	Tutorials 0h00	Lab sessions 0h00	Free labs 0h00	Project 0h00
Lectures 10h00	Tutorials 0h00	Lab sessions 0h00	Free labs 0h00	Project 0h00					
Taught in English: 		SD/SR: 	Innovation: 						




Automotive Engineering for Sustainable Mobility		1AE02	Semester 1	
Scientific pre-requisite				
Supervisor: Meryem JABLOUN			ECTS : 5	
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">Acquire skills and an understanding of mathematical tools necessary for studying and exploring characteristics of linear systems				
Syllabus				
Fourier series decomposition				
Perform Fourier Series decomposition on continous-time periodic signals and understand Gibbs phenomenon				
Linear differential equations				
Solve linear differential equations: 1st and 2nd order cases: illustration and application to physical systems				
Grading				
Written exam				
Learning hours				
Lectures 28h45	Tutorials 21h15	Lab sessions 0h00	Free labs 1h15	Project 0h00
In person teaching: 50h00				
Taught in English: 		SD/SR:	Innovation:	




Automotive Engineering for Sustainable Mobility		1AE03	Semester 1					
<h1>Electrical engineering</h1>								
ECTS : 5								
<h2>Skills</h2> <p>At the end of this course, engineering students will be able to:</p> <ul style="list-style-type: none">• Understand electrical and magnetism principles occurring in electrical motors divided in two parts: electrical motors and the dedicated converters• Understand the inner working of continuous and synchronous motors• Quantify the electrical efficiencies using active power, reactive power, apparent power, distortion power and power factor								
<h2>Syllabus</h2> <ul style="list-style-type: none">• Power: quantifying yields and efficiencies• Active, reactive, apparent, distortion power, power factor• Three phased system grid• Harmonic aspects in power and electromagnetic pollution• Magnetism applied to electrical motors. Loss reduction in permanent magnet rotors of synchronous machines• Continuous motors and AC/DC, DC/DC converters integrated power electronics. Step down and the step up chopper structures• Synchronous motors in servo synchronous machines with Pulse Width Modulator frequency converter• Four practical sessions illustrate three kinds of motors and transformer needed in industrial processes								
<h2>Grading</h2> <p>Written exam, Oral exam</p>								
<h2>Learning hours</h2> <table><tr><td>Lectures 13h45</td><td>Tutorials 10h00</td><td>Lab sessions 26h15</td><td>Free labs 0h00</td><td>Project 0h00</td></tr></table> <p>In person teaching: 50h00</p>				Lectures 13h45	Tutorials 10h00	Lab sessions 26h15	Free labs 0h00	Project 0h00
Lectures 13h45	Tutorials 10h00	Lab sessions 26h15	Free labs 0h00	Project 0h00				
Taught in English: 		SD/SR: 	Innovation: 					


Automotive Engineering for Sustainable Mobility		1AE04	Semester 1	
IT: programming				
Supervisor: Rachid JENNANE		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">Analyze a problemPropose an algorithmDevelop an object architecture for a given problemUse a development environment and a C/C++ compiler				
Syllabus				
Basics				
<ul style="list-style-type: none">Structure of a program in C languageBasic elements (character, type, constants, variables, blocs, etc.)Instructions and OperatorsConditional structures, iterative structures and connections, etc.Pointers and dynamic variablesArraysStringsFunctions, passing parameters by value, by reference and by address				
Object oriented programming				
<ul style="list-style-type: none">ClassesMember variables and member functionsSpecialized constructorsOverloaded functions and operatorsData streamAbstract classesGeneric classes				
Grading				
Written exam				
Learning hours				
Lectures 16h15	Tutorials 0h00	Lab sessions 33h45	Free labs 13h45	Project 0h00
In person teaching: 50h00				
Taught in English: 		SD/SR:		Innovation: 


Automotive Engineering for Sustainable Mobility		1AE05	Semester 1	
Advanced physics				
Supervisor: Azeddine KOURTA		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Understand the inner working of power electronics• Understand basic automotive aerodynamics• Solve 1st and 2nd principle based thermodynamic problems				
Syllabus				
Power electronics				
<ul style="list-style-type: none">• Semi-conductor physics• Power MOS• IGBT				
Automotive aerodynamics				
<ul style="list-style-type: none">• Basics of aerodynamics• Specificities of automotive aerodynamics• Wind tunnel experiments				
Thermodynamics				
<ul style="list-style-type: none">• 1st and 2nd principle of thermodynamics• Ideal gases• Basic engine cycles				
Grading				
Written exam, Report				
Learning hours				
Lectures 32h30	Tutorials 13h45	Lab sessions 3h45	Free labs 0h00	Project 0h00
In person teaching: 50h00				
Taught in English: 		SD/SR: 	Innovation: 	




Automotive Engineering for Sustainable Mobility		1AE06	Semester 1	
French culture and language				
Supervisor: Geanina BOUTONNE		ECTS : 4		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Understand spoken french and speak basic sentences• Read and write basic french• Hold a basic conversation				
Syllabus				
<ul style="list-style-type: none">• French language sounds• French grammar• French conjugation• Interactive discussions in French				
Grading				
Written exam, Oral exam				
Learning hours				
Lectures 0h00	Tutorials 70h00	Lab sessions 0h00	Free labs 0h00	Project 0h00
In person teaching: 70h00				
Taught in English:		SD/SR:	Innovation:	

Automotive Engineering for Sustainable Mobility		1AE07	Semester 1	
Vehicle Dynamics 1				
Supervisor: Pascal HIGELIN		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Understand vocabulary, technology and general issues and goals of vehicle dynamics applied to passenger cars• Choose and model a tire. Design or choose front and rear axles technologies according to an expected behavior. Design suspension systems and anti roll bars• Model the behavior of a car using several numerical models, and compare them to real world test measurements• Conduct experimental measurements on a real axle or a complete vehicle to obtain the variation of the geometrical characteristics length and angles for roll, pumping and pitching				
Syllabus				
<ul style="list-style-type: none">• Generalities: SAE Coordinate System. Definition of specific vocabulary. Motion variables. Basic geometry of an Axle (toe, caster, camber, kingpin etc.) and its effect on drivability• Tire: Constitution and behavior. Vertical, longitudinal and lateral modelling. Auto- align torque. Pacejka Model and introduction to TM Easy Model• Axle: Kinematics modelling of various axle using the theory of the mechanism. Suspension steer and roll properties. Analysis of the design effects on the change of characteristic angles and length (toe, camber etc.) as a function of pumping and rolling. Roll Center of an axle• Vertical behavior and suspension design. Spring and shock absorber design for sprung mass, un-sprung mass control in the case of pitching and pumping behavior• Transversal Behavior: Ackermann Geometry. Jeantaud's steering system. Bicycle Model. Over steer coefficient, characteristic speed, yaw speed gain. Roll Stiffness of an axle. Roll Flexibility. Lateral Load Transfer. Anti-roll bar design• Numerical simulations and comparison to real test results using several models (Simulink, Thesis)• Practical work 1: Experimental measurements and modeling of the kinematics roll effects on camber and steering angle for the H-Frame axle• Practical Work 2: Experimental measurement of suspension steer, roll effect and pitch effect on the geometrical characteristic angles, for a complete car, in case of pure pumping				
Grading				
Written exam, Oral exam, Report				
Learning hours				
Lectures 35h00	Tutorials 22h30	Lab sessions 7h30	Free labs 0h00	Project 0h00
In person teaching: 65h00				
Taught in English: 		SD/SR: 	Innovation: 	




Automotive Engineering for Sustainable Mobility		1AE08	Semester 1	
Internal combustion engines				
Supervisor: Pascal HIGELIN		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Understand the physical and chemical processes occurring during combustion and scavenging in internal combustion engines. Understand the behavior of an engine when changing its settings using modeling• Be able to build an internal combustion engine model. Be able to optimize the size and settings of an engine performance under efficiency, power, emission constraints using modeling				
Syllabus				
<ul style="list-style-type: none">• Combustion: Thermochemistry and Kinetics applied to combustion. The self-ignition. Premixed flames, flammability limits, flame stability, turbulent combustion. Diffusion flames, biphasic combustion. Internal aerodynamics of an engine. Mixture preparation, requirements of spark ignition and self-ignition, initiation and propagation of combustion (definition of core burning speeds), formation of pollutants. Identification of engine manufacturers needs in terms of fundamentals• Thermodynamic models: Classification of thermodynamic models: air cycle models, one and two zone models, multizone models. Combustion chamber walls losses models. Limits of validity• Combustion models: semi-empirical combustion models, application to spark ignition engines. Extension to compression ignition engines. Combustion models for spark ignition engines. Combustion models for compression-ignition engines (spray patterns, combustion models in the premix and diffusion phase)• Scavenging models: filling/emptying models and acoustic 1D intake/exhaust. Boundary conditions: open tubing, closed, partially open junctions. Consideration of thermal losses and friction to the walls. Filling efficiency curves reconstruction• Specific Tool: Matlab/Simulink, GTpower, CHEMKIN				
Grading				
Written exam, Oral exam, Report				
Learning hours				
Lectures 16h15	Tutorials 41h15	Lab sessions 7h30	Free labs 0h00	Project 0h00
In person teaching: 65h00				
Taught in English: 		SD/SR: 	Innovation: 	



Automotive Engineering for Sustainable Mobility		2AE01	Semester 2	
Acquisition systems and signal processing				
Supervisor: Philippe RAVIER			ECTS : 5	
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Mastering Analog to Digital conversion for digital systems• Mastering the Fourier Transform for spectral analysis of the data• Selecting and implementing an FIR or IIR filter on a dedicated hardware or software architecture				
Syllabus				
Signal processing basics				
<ul style="list-style-type: none">• Analog and digital representation, Shannon theorem• Time and frequency representation• Fourier transform• Noise processing				
Digital filtering				
<ul style="list-style-type: none">• Z transform for digital signals• Transverse filters• Recursive filters				
Grading				
Written exam				
Learning hours				
Lectures 20h00	Tutorials 20h00	Lab sessions 10h00	Free labs 0h00	Project 0h00
In person teaching: 50h00				
Taught in English: 		SD/SR:	Innovation:	

Automotive Engineering for Sustainable Mobility		2AE02	Semester 2	
Real Time Programming				
Supervisor: Raphaël CANALS			ECTS : 5	
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Mastering techniques for the implementation of digital systems• Understanding and implementing hardware and software for real-time systems• Controlling the CAN and FlexRay communication buses				
Syllabus				
Digital systems				
<ul style="list-style-type: none">• Number coding and algebra• Analog-to-digital and digital-to-analog conversions				
Electronic components				
Microcontrollers: applications in automobile				
Microcontrollers: structure and implementation				
Architecture of a microcontroller board				
Role and place of an OS on a processor board				
Architecture of an OS				
Calls to OS functions				
Automotive communication buses				
CAN and FlexRay buses architecture				
Communication protocols				
Grading				
Written exam				
Learning hours				
Lectures 17h30		Tutorials 10h00	Lab sessions 13h45	Free labs 2h30
				Project 8h45
In person teaching: 50h00				
Taught in English: 		SD/SR:		Innovation:

Automotive Engineering for Sustainable Mobility		2AE03	Semester 2	
Control & Simulation of Powertrains				
Supervisor: Alain CHARLET		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Understanding why and how hybridization works• Understanding where energy is lost in a car vs driving conditions• Being able to build a simple model of a car and its control				
Syllabus				
Part 1: Control of powertrains				
Anti-lock Bracking System (ABS) & Cruise control. This study is performed in simulation with the software Matlab/Simulink				
Part 2: Simulation of powertrains				
An overview of electric hybrid powertrains is proposed				
Then, students work on a simulation platform (Simcenter AMESim by Siemens) where they have to build an energy balance of a conventional vehicle				
This study is completed by two practical classes on a rolling test bed where students measure energetic performances of a conventional car vs hybrid car (Toyota Yaris)				
Grading				
Written exam, Oral exam				
Learning hours				
Lectures 5h00	Tutorials 22h30	Lab sessions 7h30	Free labs 0h00	Project 0h00
In person teaching: 35h00				
Taught in English: 		SD/SR:		Innovation: 

Automotive Engineering for Sustainable Mobility		2AE04	Semester 2	
Project				
Supervisor: Pascal HIGELIN			ECTS : 10	
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">• Split a complex task into subtasks. Plan and schedule tasks• Work as a group. Assign tasks to members of the group taking dependencies into account• Select the more adequate modeling level and simulation tool• Present work performed in a concise way focusing on the most important aspects• Build working powertrain and vehicle dynamics models based on experimental data				
Syllabus				
<ul style="list-style-type: none">• Reformulation of project subject• Split subject objectives into tasks and sub-tasks• Schedule tasks and assign them to project members• Report work performed, current state and upcoming tasks every 2 weeks				
Grading				
Thesis, Oral exam				
Learning hours				
Lectures 0h00		Tutorials 0h00	Lab sessions 0h00	Free labs 0h00
				Project 130h00
In person teaching: 130h00				
Taught in English: 100%		SD/SR:		Innovation:

Automotive Engineering for Sustainable Mobility		2AE05	Semester 2	
Control and on-board diagnosis applied to ICE				
Supervisor: Guillaume COLIN		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">Find the good set of parameters for a PID controller on simple systemsTune an internal combustion engine controlControl some simple actuatorsDefine, parameterize and implement a simple observer-based diagnosis tool				
Syllabus				
State of the art of engine control: sensors, actuators				
<ul style="list-style-type: none">Gasoline enginesDiesel engines				
Automatic control				
<ul style="list-style-type: none">Linear Models (1st order, 2nd order)Conventional Linear Control (PID)				
Applications to powertrain control : labs				
<ul style="list-style-type: none">Experimental engine test benches : tuning and controlHardware in the Loop (HIL) & Rapid prototyping for Control: Application on valves				
On Board Diagnosis				
<ul style="list-style-type: none">Rule based diagnosisObserver based diagnosis with numerical simulations on Matlab/Simulink				
Grading				
Written exam, Oral exam				
Learning hours				
Lectures 23h45	Tutorials 10h00	Lab sessions 16h15	Free labs 0h00	Project 0h00
In person teaching: 50h00				
Taught in English: 		SD/SR: 	Innovation: 	

Automotive Engineering for Sustainable Mobility		2AE06	Semester 2	
Control and on-board diagnosis applied to vehicle dynamics				
Supervisor: Guillaume COLIN		ECTS : 5		
Skills				
At the end of this course, engineering students will be able to:				
<ul style="list-style-type: none">Find the good set of parameters for a PID controller on simple systemsTune a vehicle dynamics controlControl some simple actuatorsDefine, parameterize and implement a simple observer-based diagnosis tool				
Syllabus				
State of the art				
Hardware (sensors, actuators...)				
Software				
Automatic control				
<ul style="list-style-type: none">Linear Models (1st order, 2nd order)Conventional Linear Control (PID)				
Applications to vehicle dynamics : labs				
<ul style="list-style-type: none">Tuning a vehicle dynamics controllerHardware in the Loop (HIL) & Rapid prototyping for Control: Application on valves				
On Board Diagnosis				
<ul style="list-style-type: none">Rule based diagnosisObserver based diagnosis with numerical simulations on Matlab/Simulink				
Grading				
Written exam, Oral exam				
Learning hours				
Lectures 31h15	Tutorials 8h45	Lab sessions 10h00	Free labs 0h00	Project 0h00
In person teaching: 50h00				
Taught in English: 		SD/SR: 	Innovation: 