Semester 3 (Nevers)

		EMC-SM	VDIV-SM	EMC-SM	VDIV-SM
Code	**Title**	**Hours**		**ECTS**	
UE-1	Vehicular networks *Prof. Dr. Sidi Mohammed Senouci & Ass. Prof. Dr. Philippe Brunet*	35	45	4	6
UE3-2	Energy hybridization/Storage *Ass. Prof. Dr. Yujun Cao*	45	45	5	5
UE3-3	Engine Components (injection, turbomachinery) *Prof. Dr. Luis Le Moyne*	20		4	
UE3-4	Electrical powertrain *Prof. Dr. El-Hassane Aglzim*	45	45	5	5
UE3-5A	Alternative fuels and pollutant reduction *Prof. Dr. Benoite Lefort & Prof. Dr. Hong-Quan Do*	45		5	
UE3-5B	Autonomous vehicles *Ass. Prof. Dr. Ahmed Chaibet*		55		7
UE3-6	French culture and language *Ass. Prof. Rémy Prieur*	50	50	2	2
UE3-7	Professional conferences *Ass. Prof. Dr. Julien Jouanguy*	30	30	2	2
UE3-8	Project *Ass. Prof. Dr. Julien Jouanguy*	60	60	3	3
		330	**330**	**30**	**30**

AESM Master **EMC** **Semester 3**

Alternative Fuels and pollutant reduction

Academic advisors: **Benoite LEFORT** **ECTS: 5**

Objectives

Objective 1: better understanding of the formation of pollutants
Objective 2: overview of strategies to reduce pollutant

Prerequisites

Module TC1-1: Trends in Automotive and Transportation: Past and present Transportation economy for Future
Module TC1-6: Internal Combustion engines

Competences

Competence 1: Understand and model pollutants formation
Competence 2: Define engine control strategies and engine concept to reduce pollutants

Contents

Title 1: Pollution formation

This course provides an introduction to the chemistry of combustion. The emphasis is on basic principles of thermodynamics, chemical kinetics in combustion:
- Fossil fuels (petroleum, coal, natural gas)
- Mechanisms of NOx, PAH and soot
- Pollutants and atmospheric effects

Title 2: Pollutant reduction and alternative combustion

This course provides an overview of the strategies to reduce pollutants emission :

- After-treatment process in order to reduce pollutant in the exhaust gas from internal combustion engines (catalyst, particulate, NOx trap)
- In-cylinder pollutant reduction (EGR)
- Alternative combustion processes (HCCI, biofuels)

Evaluation

Litterature review project (report and presentation)
Labs

Schedule

Lecture	Lecture/Course	Course	Lab	Project
(1) 9 h	XX h	5 h	6 h	4.5 h
(2) 11 h	XX h	1 h	9 h	4.5 h

Total hours / student: 50 h

AESM Master **VDIV** **Semester 3**

Autonomous Vehicle

Academic advisors: **Dr. Ahmed CHAIBET** **ECTS: 7**

Objectives

Through this module we aim to address the knowledge-gap in the area of autonomous and self-driving cars including: Perception, Location and cartography, HMI, Acceptability of the technology, legal aspects, Decision making and machine learning, computer vision, platooning, communication, ...

Prerequisites

Prerequisites 2: Calculus Course and Numerical Methods - Mathlab

Competences

Perception, Location and cartography, HMI, Acceptability of the technology, Decision making in autonomous systems, machine learning, computer vision, platooning, communication,..

Contents

Basic concepts about autonomous vehicles

- What is autonomy? Different degrees of autonomy. Technological, legislative and societal challenges
- How to control an autonomous vehicle? (perception/action loop, actuators, usual control/command techniques, reactive control techniques.
- Collaborations between vehicles (fleets and convoy of vehicles, vehicle crossings, etc.)

Basic concepts and algorithms about localization

- How to localize robots in various environments
- Sensors, estimation process, SLAM, absolute localization.

System control (signal and servo)

- Longitudinal / lateral control
- Proportional-Integral-Derivative (PID) Control

Technology acceptability

- According to Social Identity Theory, Self-Categorization Theory, Theory of Planned Behavior, you will explore threats and opportunities that underlay the adoption of autonomous vehicles.
- Presentation of this scope through a series of applied studies (some of them, having been performed in Bourgogne-Franche Comté).

Basic concepts on Vision/Perception of autonomous vehicles

- Initiation to artificial vision
- Image processing using Open CV / C programming

Legal aspects

- Actors in charge of the emergence of the autonomous vehicle

- Assimilation of the autonomous vehicle to the robot – Necessity of an adequate regulation
- Unprecedented legal and ethical questions. New issues for public persons
- Main current standards applicable
- Problem of personal data for the autonomous vehicle
- Question of liability and the insurance system for the autonomous vehicle

Evaluation

Literature review project (report and presentation) + Final written examination + Labs

Schedule

Lecture	Lecture/Course	Course	Lab	Project
XX h	XX h	XX h	XX h	XX h

Total hours / student: 60 h

AESM Master **EMC & VDIV** **Semester 3**

Electrical powertrain

Academic advisor: Pr. El-Hassane AGLZIM **ECTS: 5**

Objectives

The electric and hybrid systems in automotive and transportation are a current topic and very great interest. They are seen as an immediate solution to reduce fuel consumption and harmful emission of molecules. A large portion of the vehicles in the future will be hybrid vehicles. At the same time they mark the passage of the internal combustion vehicles to electric vehicles.
This course prepares the student to carry out the master's programme by presenting the models of each elementary function as well as the different architectures forming the complete chain of electric transmission.

Prerequisites

Matlab/Simulink, Electrical engineering, Power electronics, Vehicle Dynamics, Electrical machines, Transmission system, Curiosity of an engineer

Competences

At the end of this EU you will have knowledges on the differences between internal combustion vehicles, hybrid vehicles and electric vehicles with the used components and architectures applied. You will know the difference between the levels of hybridization in hybrid vehicles and their applications. You will know the basics of applying hybrid control system, the main elements that are used to form hybrid architectures including batteries, fuel cell systems and other.

Contents

Electric vehicles

- History, Previsions of development, System Overview, Recharge.

Hybrid definition

- Architectures, series hybrid, Noao, Operation patterns.

Series and parallel hybrid

Control strategies, Sizing of the major components, design of the drive train parameters.

Regenerative braking

Auxiliaries, Power steering, climatisation.

Components in electrical railway traction

History, Energy production, Capture and protections, electrical conversion.

Evaluation

Examen : 2/3
Pratical works + Project : 1/3

Schedule

Lecture	Lecture/Course	Course	Lab	Project
13.5 h	XX h	9 h	21 h	6 h

Total hours / student: 50 h

AESM Master **EMC & VDIV** **Semester 3**

Energy hybridation/Storage

Academic advisor: Dr. Yujun CAO **ECTS: 5**

Objectives

In order to store energy in a convenient form you need means of storage, the storage can be electrochemical, electrical or mechanical.
Different devices exist for the different means of storage. Those elements are key elements for the hybridization of vehicles.
The knowledge of means of storage completes the portfolio of an automotive engineer who is prepared to face the profound changes that this domain undergoes.

Prerequisites

Bachelor in engineering in the domain mechanical engineering, automotive engineering, electrical engineering, mecatronics or other domain close. Knowlege from the first year of AESM like electric engineering, internal combustion engines and control and simulation of powertrains.

Competences

At the end of the lecture students will have profound knowledge of the different types of energy storages used for vehicle applications, you are not only able to describe their basics, but also the constraints, based on that you are able to dimension the energy storage for a given application.
Different energy storage systems and their application area taking into consideration also aspects of weight and volume as well as economic aspects.
The discussed storage systems are: different types of batteries, super capacitors, fuel cell systems, fly wheels as well as basics of hydrogen and renewable energy production.

Contents

Batteries

Electrochemical Basics
Key Parameters
Battery types (Lead Acid, Nickel Metal Hydride, Lithium Ion, etc)
Recharge

Fuel Cell

Working Principle
Types of fuel cells (PEFC, PAFC, MCFC, SOFC)
Voltage and power
Fuel Cell System
Hydrogen Storage

Supercapactior

Electrochemical basics
Working Principle
Mobile Applications

Flywheels

General Approach
Mobile Applications

All lectures are come along with exercises on different mobile applications of energy storages, that give a more précise view on the application and dimensioning of the discussed systems.

Evaluation

The evaluation will be in form of one or multiple continuous controls, which can be quizzes, exercises, tests, graded homework or mini projects. The marks on the lab reports and a final exam.

Schedule

Lecture	Lecture/Course	Course	Lab	Project
12 h	XX h	12 h	15 h	XX h

Total hours / student: 39 h

AESM Master **EMC** **Semester 3**

Engine Components

Academic advisor: **Pr. LE MOYNE Luis** **ECTS: 4**

Objectives

Typically, to be able to this question: What are the characteristics and trends of progress of the main components and principal functions of combustion engines?

Prerequisites

Prerequisites in chemics, hydrocarbons families and characteristics, key components of ordinary and alternative fuel.

Competences

At the end of this module the students should be capable of:

- Competence 1: Design engine components
- Competence 2: Evaluate the efficiency gains of engine components technological changes

Contents

- The detailed processes of mixture formation: intake, transport, fuel atomization and vaporization, turbulence, etc.
- The technological items related to injection, design and characteristics related to engine control and calibration
- The external components of gas circuit (compressor, turbine, EGR valve, intercooler, etc.), along with their characteristics and functions and design methods.

Evaluation

Written examination, project.

Schedule

Lecture	Lecture/Course	Course	Lab	Project
XX h	XX h	XX h	XX h	XX h

Total hours / student: 20 h

AESM Master **EMC & VDIV** **Semester 3**

Module name: F.L.E (Français Langue Etrangère)

Academic advisors: **Rémy PRIEUR** **ECTS: 2 (1 if one option)**

Objectives

Objective 1: Enable the students to understand and to be able to communicate in French.
Objective 2: Enable the students to write CV's, motivation letters and internship reports.
Objective 3: Prepare the students for oral interviews.

Prerequisites

Prerequisite 1: A basic understanding and knowledge of French spelling and grammar.
Prerequisite 2: A basic grasp of French phoneme pronunciation.

Competences

Competence 1: A basic understanding and knowledge of French spelling and grammar.
Competence 2: A basic grasp of French phoneme pronunciation.

Contents

Content 1

- CV writing: overview of the structure, format, contents and linguistic expressions
- Motivation letter: overview of the structure, format, contents and linguistic expressions
- Vocabulary: the study of cultural, technical and scientific articles
- Grammar: Revision of grammar rules through writing exercises

Content 2

- Internship report: overview of the methodology
- Interview: preparation through testing and role play
- Comprehension: Study of French dialogues, videos, and music
- Conversation: Speaking activities including role play, debate and individual student presentations

Evaluation

Evaluation terms: The completion of a CV and a letter of motivation.
Participation in group work and individual oral presentations.

Schedule

Lecture	Lecture/Course	Course	Lab	Project
XX h	XX h	XX h	XX h	XX h

Total hours / student: 50 h

AESM Master **EMC & VDIV** **Semester 3**

Professional Conferences

Academic advisors: **Julien JOUANGUY** **ECTS: 2**

Objectives

In this module, we try to provide students with a series of conferences given by professionals (industrials and academics) from the domain of automotive and sustainable mobility.

Prerequisites

N.A.

Competences

At the end of the course, student should be comfortable with: Fundamentals of Aerodynamics and CFD, Interface design, project management, Energy management, New engines, New materials, etc.

Contents

Evaluation

Projects

Schedule

Lecture	Lecture/Course	Course	Lab	Project
XX h	XX h	XX h	XX h	XX h

Total hours / student: 30 h

AESM Master **EMC & VDIV** **Semester 3**

Projects

Academic advisors: **Dr. Julien JOUANGUY** **ECTS: 3**

Objectives

The students are proposed to apply their theoretical competencies within practical studies in a research team. A short literature review is followed by the conception and realization of a part of a prototype.

Prerequisites

Prerequisites: Depends on the project

Competences

Depends on the project

Example of projects

- Chain of smart and autonomous electric vehicles (platooning)
- Design of an urban simulation environment
- Designing and installation of a practical workshop on autonomous robots (small vehicles)
- Assessment of euro 6b regulation, implementation and modelling of real driving tests
- Well to wheel analysis of the different solution for mobility - Impact of the different energy sources (wind turbine, solar, nuclear,..), impact of the powertrain architecture
- Assessment of ECMS strategy for Energy Management in Powertrains
- SLaTCoW (Spatial Laplace Transform for Complex Wavenumber recovery) Python Application

Evaluation

Project final presentation (report and presentation)

Schedule

Lecture	Lecture/Course	Course	Lab	Project
XX h	XX h	XX h	XX h	6 h

Total hours / student: 60 h

AESM Master **EMC & VDIV** **Semester 3**

Vehicular Networks

Academic advisors: Pr. Sidi Mohammed Senouci **ECTS: 4 (EMC)/6(VDIV)**

Objectives

The objective of this module focuses on vehicular communications (In-vehicle and inter-vehicle communications). We will start by some basic concepts on communications networks (Ethernet, IP, etc.) before detailing vehicular networks communications.
A second part of this lecture will be dedicated to the on-board diagnosis (OBD) for the VDIV students.

Prerequisites

Prerequisites 1: Basic knowledge on programming language (C/Python).
Prerequisites 2: Calculus Course and Numerical Methods

Competences

Basic concepts about networking, Understanding in-vehicle, vehicle-to-vehicle, and vehicle-to-infrastructure communications (Wifi, IEEE 802.11p-G5, Wimax, WAVE, DSRC, 4G LTE, Ethernet, CAN, FlexRay, MOST, etc.)

Contents

Basic concepts about networking

- What is a network?
- Network classification
- Network standards
- Layered architecture
- Network interconnection
- TCP/IP Architecture (Internet)

Understanding in-vehicle, vehicle-to-vehicle, and vehicle-to-infrastructure communications

- Wifi
- Wimax
- WAVE 802.11p
- DSRC
- Cellular networks (3G, 4G LTE)
- Embedded networks (Ethernet, CAN, FlexRay, MOST, etc.)

On Board Diagnosis (VDIV only)

- Rule based diagnosis
- Observer based diagnosis with numerical simulations

Evaluation

Literature review project (report and presentation) + Final written examination + Labs

Schedule

Lecture	Lecture/Course	Course	Lab	Project
9 h		10 h	12 h	9 h
4 h (VDIV)			6 h (VDIV)	

Total hours / student: 40 h +10h (VDIV)