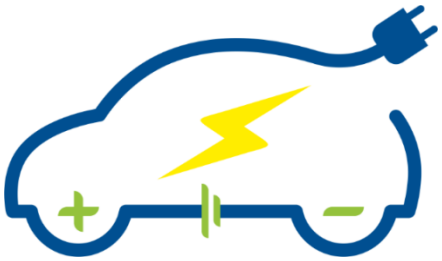

E – DRIVETOUR

Beyond the Border of Electric Vehicles: an Advanced Interactive Course

Erasmus+ Programme: Knowledge Alliances

Project Number: 612522-EPP-1-2019-1-EL-EPPKA2-KA

D1.1 Course Requirements
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Revision and history chart:

VERSION	DATE	EDITORS	COMMENT
V 0.1	31/01/20	IHU	First draft version
V 0.2	12/04/20	IHU	1st version with courses prepared
V 0.3	04/05/20	IHU	Review and upload on Google Drive
V 1.0	15/05/20	IHU	Partner Replacement

Table of content

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1 Executive summary

The main objective of this document is to define the E-DRIVETOUR project foundations that will further enable the implementation of the course development activities in the project.

Initially the project courses defined in the proposal are extracted and analyzed in order to drive the whole course specification process and to allow a quick overview of the content that will be developed. These will then be further elaborated during the WP2 and the development of the course content.

The list of requirements for each course is derived through the involvement of the respective developers. Suitable forms were compiled to capture & organise the information. In total 24 forms were created, one for each course.

The current version of the document is established as the deliverable about the E-DRIVETOUR course specifications and will be considered as the reference point for all project activities (Application Requirements & Specifications –WP1, Academic Curriculum Development –WP2, Development of Reconfigurable Laboratory Apparatus –WP3 and Integration, Deployment & Benchmarking – WP4).

Two important changes with respect to the proposal are mentioned in the document, a slight change in tow courses and the replacement of a partner withdrawn with a new partner.

The generated syllabus specification forms are included in the Annex of this deliverable and they contain all the necessary information for the implementation of each course as standalone and the set of courses as a complete curriculum.

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2 Objectives of the report

2.1 Purpose of the Document

The main objective of this document is to define the course requirements of the E-DRIVETOUR project. The syllabus for each of the courses of the two educational periods (time slots 1 and 2) is defined in detail. All the essential parameters required to describe all aspects of a course are set and described if applicable. The course title, the teaching period, the course code, student effort analysis, course prerequisites, contents, literature, learning outcomes are among the characteristics to be defined for each course. The syllabus and the teaching material requirements for the overall curriculum are the final outcome of this deliverable.

2.2 Scope of the Document

This document is aimed to define the project foundations; to create the necessary inputs for the E-DRIVETOUR experiment & demonstrator specifications in T1.2 & T1.3 respectively. In addition, the extraction of the course requirements will enable the implementation of the Academic Curriculum Development (in WP2) and the Development of the Reconfigurable Laboratory Apparatus (in WP3). It is clear that the work performed in this task will support the rest of project activities in WP1-WP3.

2.3 Structure of the Document

The document includes the following contents:

- In *chapter 2*, the introductory section is provided, highlighting the scope and objective of the deliverable
- Following, *chapter 3*, presents the project educational program and describes the course characteristics to be defined as the essential requirements
- *Chapter 4* describes the connection of Task 1.1 and the specific Deliverable with the forthcoming activities
- In *chapter 5*, a summary and the main conclusions of the work are reported in the last chapter of the deliverable
- *Chapter 6* contains the bibliographical references of the present document

Finally, Annexes I and II contain the supportive information towards the definition of the project foundations, namely:

Annex I - Course Syllabus Template Form

Annex II – Courses' Syllabus

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3 Conclusions

The requirements for the individual courses of the curriculum are defined by this document. Crucial parameters of each course like the teaching and working hours were analysed, the teaching content, the learning outcomes, the objectives and competences acquired by the students as well as the teaching methods and assessment methodology are clearly defined. An appropriate form was filled in with all the aforementioned information. Moreover, the teaching material for all teaching methods used for each course was defined in more detail. Educational notes, oral presentation files, videos, possible homework etc are among the teaching material kinds that were declared and defined. An appropriate file was prepared for each course. Therefore, two file forms per course were prepared for each course and are attached to this document.

The document together with all its attachments will set the basis for all other tasks to be taken place in the same WP as well as in the forthcoming WPs and especially WP2 which requires the development of the actual teaching material as well as the examinations and homework material.

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4 ANNEX I – Courses syllabus

The following files are attached as integral part of the present document.

- *TS1.1 - Introduction to Vehicle Electrification.pdf*
- *TS1.2 - NI LabVIEW Training.pdf*
- *TS1.3 - Automotive Energy Sources.pdf*
- *TS1.4 - Lightweight Materials.pdf*
- *TS1.5 - Introduction to Vehicle Dynamics.pdf*
- *TS1.6 - Data acquisition and EV Sensors.pdf*
- *TS1.7 - EV Production Management.pdf*
- *TS1.8 - Electric Motors & Motor Drives for EVs.pdf*
- *TS1.9 – Autonomous Vehicles.pdf*
- *TS1.10 - EV Business Administration and Automotive Marketing.pdf*
- *TS1.11 - Language Lessons Greek.pdf*
- *TS1.12 - Intermediate Project 1.pdf*
- *TS2.1 - EV System Modelling and Simulation.pdf*
- *TS2.2 – EV Energy Storage Systems.pdf*
- *TS2.3 - EV Charging Systems.pdf*
- *TS2.4 - Mechanical Drivetrains for EVs.pdf*
- *TS2.5 - Control System Development.pdf*
- *TS2.6 - EV Public Policies.pdf*
- *TS2.7 - EVs and Smart Grinding.pdf*
- *TS2.8 - EV On Board Diagnostics, Troubleshooting & Maintenance.pdf*
- *TS2.9 - Life Cycle Assessment of EV's.pdf*
- *TS2.10 - Sustainable Transportation.pdf*
- *TS2.11 - Language Lessons Polish.pdf*
- *TS2.12 - Intermediate Project 2.pdf*

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Introduction to Vehicle Electrification

Teaching Period	Course Code
First Term	TS1.1

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
3				1.5	0.5

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

None

Content (Syllabus Outline)

This course is an introduction to Vehicle Electrification, covering general information about architectures of all possible vehicles with electric powertrain such as the Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), Fuel Cell Electric Vehicles (FCEVs), Solar Cell Electric Vehicles etc. The course explains the functionality of EVs, including the basics on energy storage as well as the technologies applied for charging them, the various cases of propulsion system and basic accessories. Emphasis will be given to the basic electric powertrain structural components for vehicle operations. The participants will also get a brief glance on future EV market, technological & market trends such as autonomous EVs.

Objectives and Competences

Objectives

- to introduce students to vehicle electrification
- to provide the students an insight to the structural elements of an electric powertrain

Competences

- to recognize and understand an electric powertrain and its main structural elements

Intended Learning Outcomes

Students that will successfully attend the course will be able
- to recognize and describe electric and hybrid electric vehicle structure
- to discuss upon an electric powertrain
- to satisfactorily present a subject related to vehicle electrification
- to analyze the structure of an electric vehicle

Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Laboratory presentation of components
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 70%
2. Homework, appointed to students in small groups or personal. Weighting Factor: 30%
The course ECTS are granted to the students if both parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (70%) + Homework (30%)

Basic Literature

- M. Ehsani, Y. Gao and A. Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", fundamental, theory and design,2nd ed.,CRC Press: Boca Raton, 2010. ISBN: 978-1420053982
- J. Erjavec and J. Arias, Hybrid, Electric and Fuel Cell Vehicles. Thomson Delmar Learning, 2007. ISBN: 978-1401881085
- C.D. Rahn, C.-Y. Wang, Battery Systems Engineering. Wiley and Sons, 2013. ISBN: 978-1119979500
- Charitonidis, F. Athanasiadis, A. Manolas and T. Kosmanis, "Development and Modeling of a Battery System for Commercial Electric Bicycles," Proceedings of 23rd International Scientific Conference on Transport Means, pp. 326-329, Palanga, Lithuania, October, 2019. ISSN 1822-296 X (print)
- Vehicle Electrification course materials at the Department of Industrial Engineering and Management of the International Hellenic University, Greece

NI LabVIEW Training

Teaching Period	Course Code
First Term	TS1.2

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6		16		3	1

Language	Lecturer
English	Cerca Trova (CT)

Prerequisites

Students must have:

- Basic knowledge of use of computers working in a Microsoft Windows environment
- Basic understanding of programming with any type of computer language (principles of programming)
- Basic understanding of electronics, electrical signals and physics related to the subject (voltage, current, time)

Content (Syllabus Outline)

The LabVIEW Training course is an introduction to National Instruments' LabVIEW graphical programming language for data acquisition and control. Topics covered include creating, editing, and executing programs using the LabVIEW interface. The course will set for the participants the bases for programming and utilizing practical data acquisition structures as well as sensor control circuits. The practical idea of real time processing, essential for surveying systems, will be introduced and the necessary knowledge in order to understand the demonstrator phase of the course will be provided. Successful attendance of the course will also lead to an appropriate certification by National Instruments.

Objectives and Competences

The objective of the course is to strengthen students' knowledge and understanding towards computer software programming also familiarizing them with data acquisition equipment used in industrial applications. These will help them understand the benefits that arise from the use of such SW & HW in the field of IoTs, so to prepare them for providing solutions related to the subject.

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Intended Learning Outcomes

Students that will successfully attend the course will be able

- Recognize & describe the structure and operation of a simple program created in Labview
- Use the essential elements of programming and Labview programming language
- Satisfactory present a simple Labview program
- Produce code and prepare simple applications that will be serve as solutions for calculations, data acquisition & management
- Analyze, improve or redesign a simple LabVIEW program according to predefined needs

Learning and Teaching Methods

- Lecture classes to give an insight to the basics of Labview software
- Lab exercises to provide the needed experience and interaction with the NI labview interface and programming
- Homework exercises to further familiarize programming, device use and data acquisition to the students

Assessment

The students will be assessed in written examinations upon given problems based on theory presented in lecture as also in form of small programming codes of which analysis and understanding by the student will be requested.
Assessment = Exam (100%)

Basic Literature

- Online NI LabVIEW tutorials (http://www.ni.com/gettingstarted/labviewbasics/)
- NI LabVIEW "Help" contents.

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Automotive Energy Sources

Teaching Period	Course Code
First Term	TS1.3

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
10	2	4		6	2

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

Students must have the:

- Fundamentals of electric circuits and electrotechnology

Content (Syllabus Outline)

The fundamentals of energy sources for vehicles in general and electric vehicles specifically are presented. The course covers battery technology as the basic energy source of electric vehicles from its constructional point of view. Battery chemistry fundamentals of most common types of batteries for electric vehicles (Li-Ion, $LiFePO_4$, $LiFeYPO_4$, NiMH, even Lead Acid ones) including their main characteristics are analyzed. Energy sources attaining a lot of attention and great importance lately, such as ultracapacitors, high speed flywheels and solar panels and systems will be significant part of the course. The course will also address topics such as chemical energy storage in fuels, hydrogen fuel cells, and the sustainability of advanced energy storage systems. Battery modeling will be a more advanced part of the course. System integration aspects into an EV will also be covered.

Objectives and Competences

The objective of the course is to

- Develop students' knowledge of energy sources used in EVs
- Understand principles of operation of various sources
- Develop practical skills as regards characterisation of energy sources

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe the construction of various automotive energy sources
- to discuss upon the differences between energy sources
- to calculate the characteristics of an automotive energy source
- to satisfactorily present a subject related to vehicle energy sources
- to analyze the structure of an energy source

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Learning and Teaching Methods

Teaching face to face
Webinar and web-based teaching
E-learning support (use of asynchronous e-learning platform)
Laboratory experiments
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory report, analyzing and commenting on the experimental results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- M. Ehsani, Y. Gao and A. Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", fundamental, theory and design,2nd ed.,CRC Press: Boca Raton, 2010. ISBN: 978-1420053982
- J. Erjavec and J. Arias, Hybrid, Electric and Fuel Cell Vehicles. Thomson Delmar Learning, 2007. ISBN: 978-1401881085
- C.D. Rahn, C.-Y. Wang, Battery Systems Engineering. Wiley and Sons, 2013. ISBN: 978-1119979500
- Arno Smets, Klaus Jäger, Olindo Isabella, René van Swaaij and Miro Zeman, Solar Energy The physics and engineering of photovoltaic conversion, technologies and systems. UIT Cambridge, 2016. ISBN: 9781906860325
- Vehicle Electrification course materials at the Department of Industrial Engineering and Management of the International Hellenic University, Greece

Lightweight Materials

Teaching Period	Course Code
First Term	TS1.4

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6		4		3	1

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

Students must have understanding on :

- Algebra
- Solid Mechanics
- Basic Knowledge in the Field of Engineering Sciences & Applications

Content (Syllabus Outline)

The course will touch the industrial trend of using lightweight materials, emphasizing in the weight reduction of vehicle mass. Carbon-fiber reinforced polymers (CFRP) for the electric vehicle frame, panels and pressurized gas tanks are technologies that will be presented in the course. Topics on the specific materials used for vehicle mass reduction, their properties, manufacturing techniques and handling, as well as comparison with corresponding properties of more conventional materials will be covered. Contents of the course are:

1. Classification of Materials
2. Structure, Properties & Performance
3. Elasticity and Plasticity Theory
4. Materials Imperfections
5. Fracture Mechanics Basics
6. Fatigue Strength & Lifetime Curves
7. Light Alloys
8. Plastics
9. Composite Materials
10. Examples & Applications

Objectives and Competences

On successful completion of the course the participants will be able to demonstrate a solid body of knowledge and skills in the field of the lightweight materials and their applications, allowing them to solve technically oriented issues related to materials applications for industrial purposes.

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Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe basic lightweight materials
- to differentiate the properties of basic lightweight materials
- to calculate the mass of simple geometrical structure of lightweight material
- to satisfactorily present parts of a vehicle made of lightweight materials
- to design simple lightweight material structures
- to use basic methodologies of producing lightweight materials.

Learning and Teaching Methods

- The course will be given in the form of lectures including video presentations
- The lecture notes will be written in English language
- The lecture notes will be available in electronic form

Assessment

The students will be assessed in final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Lab reports will also be assessed. Assessment = Exam (70%) + Lab (30%)

Basic Literature

- M. A. Meyers and K. K. Chawla, Mechanical Behavior of Materials, CAMBRIDGE UNIVERSITY PRESS,
  2nd Edition (2008). ASIN: B00E3URAGU
- M. F. Ashby and D. R. H. Jones, Engineering Materials 2, ELSEVIER, 3rd Edition (2005) ISBN: 978-0080325316
- R. Fragoudakis, A. Saigal, G. Savaidis, M. Malikoutsakis, I. Bazios, A. Savaidis, G. Pappas and S. Karditsas, Fatigue assessment and failure analysis of shot peened leaf springs, Fatigue & Fracture of Engineering Materials & Structures, Vol. 36, Issue 2, pages 92–101, (2013)
- I. Bazios, H.-J. Gudladt, Die Anrißlebensdauerabschätzung unter Berücksichtigung des statistischen Größeneinflusses am Beispiel der AlMgSi0,7-Legierung, Materialwissenschaft und Werkstofftechnik 35 (2004)
- I. Bazios, M. Decker, H.-J. Gudladt, The influence of size effects on the fatigue behaviour of the aluminium alloy AlMgSi0,7, Advances in Fracture and Damage Mechanics, Key Engineering Materials Vols. 251-252 (2003)

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Introduction to Vehicle Dynamics

Teaching Period	Course Code
First Term	TS1.5

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6				3	1

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

Students are recommended to have understanding of
- "Mathematics" and "Physics".
- "Fundamentals of vehicle design" or/and "Fundamentals of machine component design"

Content (Syllabus Outline)

The basics of vehicle dynamics including e-bikes will be taught in the course. In particular below presented topics will be disscussed as an essential knowledge for determining the traction power of a vehicle:

1. Fundamentals of vehicle movement.
2. Vehicle resistances including rolling, aerodynamic and grading.
3. Pneumatic tyre dynamics and traction parameters.
4. Dynamics of linear motion. Vehicles performance, maximum speed, gradeability, acceleration and deceleration.
5. Dynamics of lateral motion. Vehicles behaviour during cornering (oversteering, understeering, Ackerman angle).

The course is supported with analytical homework exercises. In particular students will calculate fundamental performance of selected electric vehicle based on its specific configuration.

Objectives and Competences

The main objective of the following course is to teach students how to apply the fundamental principles of vehicles dynamics in engineering practice. Particular emphasis will be given to providing support for training of future engineers equipped with value-added fundamental skills beneficial for automotive industry.

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Intended Learning Outcomes

Upon completion of the subject on Introduction to Vehicle Dynamics a students will be able to:

- recognize and describe the basics of vehicle dynamics,
- present the basics of vehicle movement,
- calculate the fundamental parameters of vehicle traction,
- satisfactorily present the basic dynamic behaviour of a vehicle,
- essentially analyze the dynamic behaviour of a vehicle.

Learning and Teaching Methods

Conventional lecture/discussion sessions supported by the multimedia presentation and resources of the e-learning platform. Compulsory homework focused on analytical study of vehicle performance.

Assessment

The performance of the individual student is assessed taking into account the ECTS grades and weighting factors (WF) of: final examination (WF 60%), homework (WF 40%). The course ECTS credits are awarded to all students after completion of the learning activities and the successful assessment of the achieved learning outcomes.
Assessment = Exam (60%) + Homework (40%)

Basic Literature

- Pacejka H. Tire and Vehicle Dynamics, Elsevier, 2012,ISBN: 9780080970165
- Gillespie T.D. Fundamentals of Vehicle dynamics, SAE 1992, ISBN: 978-1-56091-199-9
- Milliken WF and Milliken DL. Race Car Vehicle Dynamics, SAE 2003, ISBN: 978-0-7680-1127-2
- Stępniewski A. et al. Dynamics Model of a Vehicle with DC Motor. TEKA 15(1),2015, http://www.pan-ol.lublin.pl/wydawnictwa/TMot15_1/Stepniewski.pdf
- Heisler H. Advanced Vehicle Technology. Butterworth-Heinemann 2002, ISBN: 9780750651318
- Reza N. Jazar. Vehicle Dynamics: Theory and Application. Springer 2008, ISBN-13: 978-0387742434
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- Gidlewski M, Jemioł L, Żardecki D. Selected issues of control of the process of sudden obstacle avoidance by a car. IEEE 2018. DOI: 10.1109/AUTOSAFE.2018.8373328, https://journals.sagepub.com/doi/abs/10.1177/0959651818783081
- Asok K.Sen, Longwic R., Litak G., Górski K.: Analysis of cycle-to-cycle pressure oscillations in a diesel engine. Mech Syst Signal Process. 22(2), 2008, https://www.researchgate.net/publication/223214093_Analysis_of_cycle-to-cycle_pressure_oscillations_in_a_diesel_engine

Data Acquisition and Electric Vehicle Sensors

Teaching Period	Course Code
First Term	TS1.6

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6		4		3	1

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

Students are recommended to have understanding of

- Basic theory of electricity or physics

Content (Syllabus Outline)

This topic focuses on data acquisition circuits and systems, an essential part of control networks. Electric Vehicle sensors, such as current sensors, encoders and resolvers, and modern sensoring systems are analyzed together with their connectivity with electronic control units (ECUs) that support the control network. An appropriately designed laboratory session by means of NI control systems and NI LabVIEW graphical interface will complete the course. Moreover, this course provides the basics for the understanding of "NI LabVIEW Training" course.

Objectives and Competences

The objectives of this course is the student

- to be in the position to learn and understand the EV sensors and their connectivity with the EV powertrain
- to realize the necessity of sensors in an EV and their usefulness

Competences

- ability to connect and calibrate sensors in a data acquisition system

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe basic electric vehicle sensors
- to discuss upon the operation of basic electric sensors
- to calculate the parameters required to connect a sensor to an ECU
- to satisfactorily present a complete sensoring system
- to analyze, design and develop a sensoring system based on the LabVIEW environment

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Learning and Teaching Methods

Teaching face to face
Webinar and web-based teaching
E-learning support (use of asynchronous e-learning platform)
Laboratory experiments
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory report, analyzing and commenting on the experimental results. Weighting Factor: 30%

The course ECTS are granted to the students if both parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- T. Denton, Electric and Hybrid Vehicles. Taylor & Francis Ltd, 2016. ISBN: 9781138842373
- Basu A.K., Tatiya S., Bhattacharya S. (2019) Overview of Electric Vehicles (EVs) and EV Sensors. In: Bhattacharya S., Agarwal A., Prakash O., Singh S. (eds) Sensors for Automotive and Aerospace Applications. Energy, Environment, and Sustainability. Springer, Singapore. https://doi.org/10.1007/978-981-13-3290-6_7
- Fuad Un-Noor, Sanjeevikumar Padmanaban, Lucian Mihet-Popa, Mohammad Nurunnabi Mollah and Eklas Hossain, "A Comprehensive Study of Key Electric Vehicle (EV) Components, Technologies, Challenges, Impacts, and Future Direction of Development", Energies 2017, 10, 1217. doi:10.3390/en10081217
- P. Dost, A. Bouabana and C. Sourkounis, "Measurement sensors in an electric vehicles," *International Symposium on Power Electronics Power Electronics, Electrical Drives, Automation and Motion*, Sorrento, 2012, pp. 790-795. **DOI:** 10.1109/SPEEDAM.2012.6264618
- Shinji Kajiwara (November 5th 2018). Motion Dynamics Control of Electric Vehicles, New Trends in Electrical Vehicle Powertrains, Luis Romeral Martínez and Miguel Delgado Prieto, IntechOpen, DOI: 10.5772/intechopen.77261. Available from: https://www.intechopen.com/books/new-trends-in-electrical-vehicle-powertrains/motion-dynamics-control-of-electric-vehicles
- Luis Romeral Martinez and Miguel Delgado Prieto (eds.), New Trends in Electrical Vehicle Powertrains. IntechOpen, 2019. Available from: https://www.intechopen.com/books/new-trends-in-electrical-vehicle-powertrains/
- Hui Zhang, Dongpu Cao, Haiping Du (eds.), "Modeling, Dynamics and Control of Electrified Vehicles," Woodhead Publishing, 2018. ISBN 9780128127865, https://doi.org/10.1016/B978-0-12-812786-5.00016-1.

Electric Vehicle Production Management

Teaching Period	Course Code
First Term	TS1.7

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
9				4.5	1.5

Language	Lecturer
English	International Hellenic University (IHU) Hellenic Institute of Transport (HIT)

Prerequisites

None

Content (Syllabus Outline)

EV MARKET ANALYSIS

Concept of market segmentation. Customer segments and niches marketing. Analysis of an EV market segmentation – who is the most likely to buy EVs. Peculiarity of an automotive market. Micromobility and other new market concepts that EVs are fitting in.

Statistics concerning global and European EVs market. Sample marketing strategies and activities taken by EV manufacturers. EVs infrastructure and services market: chargers, charging services, vehicle monitoring services, business concepts of sharing /renting your own vehicle.

FUNDAMENTALS OF MANAGEMENT AND MARKETING

Concept of management. Management functions: planning, organizing, motivating, controlling. Levels of management (operational, tactical, strategic). Putting strategy into practice - business plan, its structure and content. Planning and defining an EV product. Product quality. Marketing strategies. SWOT analysis. CBA analysis, WTP, WTH.

Objectives and Competences

Key objectives and expected learning outcomes of the course are:

- to form a clear picture of the problems of the Production Management and to recognize these problems and their importance;
- to obtain the required theoretical training on the most basic tools and methods to deal with Production Organization problems;
- to properly select and use the appropriate methods and tools;
- to evaluate the results of the various production tools, and apply them in the most appropriate way.

Intended Learning Outcomes

Students that will successfully attend the course will be able to:

- explain the essentials of an automotive production line;
- present an adequate cost analysis for the production of goods;
- design and develop a simple automotive production and transfer line.

Learning and Teaching Methods

Teaching face to face
Webinar and web-based teaching
E-learning support (use of asynchronous e-learning platform)
Team essays / compulsory homework

Assessment

The students will be assessed in two ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 70%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
The course ECTS are granted to the students if both parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (70%) + Homework (30%)

Basic Literature

- Creating the Clean Energy Economy: Analysis of the Electric Vehicle Industry. International Economic Development Council, Washington, DC, 2013 , https://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Electric_Vehicle_Industry_Summary.pdf
- European Roadmap: European Technology and Production Concept for Electric Vehicles. ERTRAC Working Group Global Competitiveness, Version May 2011, https://egvi.eu/wp-content/uploads/2018/01/european_technologyandproduction_concept_for_ev.pdf
- Operations Management in Automotive Industries, Springer, 2014,ISBN 978-94-007-7592-3

Internet pages
- https://eafo.eu
- https://www.iea.org/reports/global-ev-outlook-2019
- https://egvi.eu/
- https://www.smev.in/ev-industry

Co-funded by the Erasmus+ Programme of the European Union

Electric Motors and Motor Drives for Electric Vehicles

Teaching Period	Course Code
First Term	TS1.8

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
12		4		6	2

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

The students are recommended to have

- Basic understanding of electromechanical energy conversion
- Fundamentals of Electric Circuits
- Fundamentals of Power Electronics Converters
- Fundamental of Control Schemes

Content (Syllabus Outline)

The course aims to introduce to students the basics of motor types and their drive systems for EVs. Basic construction and operation characteristics will be elaborated. The course will first introduce the students to the principles of electromechanical energy conversion (electromagnetism, calculation of torque and power). The most common motor types will be presented starting from DC and AC induction motors, followed by brushless and permanent magnet machines. Motor operation characteristics will be presented and discussed such as torque and power curves and motor electrical equivalent circuits used for calculations. The students will then be introduced to power electronic circuits and systems, such as basic AC/DC, DC/DC and DC/AC converter topologies. This will be followed by the elaboration of drives systems, i. the control of machines (torque and speed) with power converters. The course will also elaborate on integration concepts on-board a vehicle (eg single machine, wheel motors).

Objectives and Competences

- Develop students' knowledge of electric powertrains operation in EVs
- Understand principles of operation and control of electric machines
- Develop practical skills in machines operation and control

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Intended Learning Outcomes

Students that will successfully attend the course will be able to:

- recognize and describe the construction of EV motors
- demonstrate the operation of EV motor drives
- calculate the essential performance parameters of an existing EV motor drive
- satisfactorily present the differences between EV motor drives
- design a motor drive based on EV desired performance and market trends

Learning and Teaching Methods

The course is delivered in the form of in-class lectures, lab experiments and exercises and mini-projects (H/W)

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 50%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 25%
3. Assessment of laboratory exercises. Weighting Factor: 25%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (50%) + Homework (25%) + Lab (25%)

Basic Literature

- Bimal K. Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, 1996. ISBN: 9780780310841
- Ned Mohan, Tore Undeland, William Robins, "Power Electronics", John Wiley and Sons Inc, 2002. ISBN: 978-0471226932.
- John G. Hayes, G. Abas Goodarzi, "Electric Powertrain", John Wiley and Sons Ltd, 2018. ISBN: 978-1-119-06364-3
- Stephen J. Chapman, "Electric Machinery Fundamentals", McGraw Hill, 2011. ISBN: 978-0073529547

Co-funded by the Erasmus+ Programme of the European Union

Autonomous Vehicles

Teaching Period	Course Code
First Term	TS1.9

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
9		6		7.5	2.5

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

The students are suggested to have basic understanding of computer programming.

Content (Syllabus Outline)

The first part of the lecture covers an Introduction to (i) the use autonomous vehicles in indoor and outdoor environments along with state-of-the-art hardware and software technologies, (ii) the basic concepts of autonomous driving (perception, localization, mapping, navigation, local and global path planning), and (iii) real world applications.

The second part analyzes the basic mechanisms of path planning algorithms namely Grassfire, Dijkstra, A Star, D Lite in order to accomplish a point-to-point movement in graphs and grids. A high-level description of the algorithms is provided (pseudo code) along with an introduction to the python programming language in order to develop computer programs.

The third part introduces the use of the Robot Operating System-ROS (ROS Basics, Simultaneous Localization and Mapping -SLAM and Navigation in indoor and outdoor environments) in autonomous vehicles' applications. ROS will be used for discussing and implementing (i) a publish-subscribe method to control a robot at a simulation environment, (ii) an application for controlling a real-world robotic vehicle.

Objectives and Competences

Objectives

- to discuss the basic concepts of autonomous vehicles and real-world applications in indoor and outdoor environments
- to analyze techniques and methods for perception, localization, mapping, navigation, local and global path planning
- to provide insights to the python programming language and to the development of computer programs
- to introduce the ROS Ecosystem

Competencies

- to develop and apply path planning algorithms

- to run simulation and real-world applications using the ROS ecosystem
- to understand and appropriate interpret the results

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to demonstrate the hardware and software components of an autonomous vehicle
- to satisfactorily present a state-of-the-art architecture for developing an autonomous vehicle application
- to recognize and describe the autonomous vehicle ecosystem
- to develop path planning algorithms and control a robotic vehicle in a simulation and a real-world environment

Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Experimental exercises
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory report, analyzing and commenting on the experimental results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- Bechtsis, D., Tsolakis, N., Vlachos, D., Srai, J.S., 2018. Intelligent Autonomous Vehicles in digital supply chains: A framework for integrating innovations towards sustainable value networks. Special Issue: Innovation for sustainable development, Journal of Cleaner Production, 181, pp 60-71.
- Bechtsis, D., Moisiadis, V., Tsolakis, N., Vlachos, D., and Bochtis, D., 2019. Unmanned Ground Vehicles in Precision Farming Services: An Integrated Emulation Modelling Approach, Special Issue, Springer's CCIS, "Communications in Computer and Information Science", Volume Number CCIS 953, pp. 177-190.
- Python Programming Language https://www.python.org/about/gettingstarted/
- Planning Algorithms http://lavalle.pl/planning/
- Tutorial: Robot Operating System (ROS) http://wiki.ros.org/ROS/Tutorials
- Book: ROS Robot Programming https://community.robotsource.org/t/download-the-ros-robot-programming-book-for-free/51

Electric Vehicle Business Administration and Automotive Marketing

Teaching Period	Course Code
First Term	TS1.10

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
15				7.5	2.5

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

Students are recommended to have understanding of
- Fundamental knowledge on management

Content (Syllabus Outline)

FUNDAMENTALS OF MANAGEMENT AND ITS FUNCTIONS
Concept of management. Management functions: planning, organizing, motivating, controlling. Levels of management (operational, tactical, strategic).
Setting organizational goals. Techniques of organizing assets. Theories of motivating staff. Role and types of control.
Functions of the executive. Managerial skills. Managerial roles. Peculiarity of managing in automotive industry.
Putting strategy into practice - business plan, its structure and content.

FUNDAMENTALS OF MARKETING, ITS STRATEGIES AND INSTRUMENTS
Concept and evolution of marketing. Marketing orientation of a company. Defining marketing.
Marketing instruments - 4Ps (product, promotion, price, place).
Concept of a product. Planning and defining products. Product lifecycle. Planning an EV product. Product quality. Discussing 4Ps for an EV product. EV as an innovative product.
Marketing strategies. SWOT analysis. Strategic chances analysis. Strategies of product implement.

Objectives and Competences

The main objective of the following course is to teach students how to understand basic theories and techniques considering management and marketing in automotive industry. Moreover, students will know how to analyze and develop product strategy and marketing plan for an EV product. They will also know how to recognize and understand market trends concerning EV products.

Intended Learning Outcomes

Students that will successfully attend the course will be able to:

- describe the role and functions of business manager,
- demonstrate the theory and techniques used by managers,
- describe the basic principles of marketing and the five functions of marketing management,
- present a marketing plan for EV product,
- satisfactorily present business strategy plan,
- analyze and develop a business strategy plan.

Learning and Teaching Methods

Conventional lecture/discussion sessions supported by the multimedia presentation and resources of the e-learning platform. Compulsory homework.

Assessment

The performance of the individual student is assessed taking into account the ECTS grades and weighting factors (WF) of: final examination (WF 50%), homework (WF 30%). The course ECTS credits are awarded to all students after completion of the learning activities and the successful assessment of the achieved learning outcomes, that is if the assessment is graded by a minimum of 5/10.
Assessment = Exams(60%) + Homework (40%)

Basic Literature

- Kotler Ph., Keller K. L., Marketing management, 2011, ISBN: 978-0132102926
- Kotler Ph., Armstrong G., Principles of marketing, 2017, ISBN: 978-0133856460
- Armstrong G., Kotler Ph., Marketing an Introduction, 2019, ISBN-13: 978-0131424104
- Candelo E., Marketing Innovation in the Automotive Industry, 2019, ISBN: 978-3030160012
- Diehlmann J., Hacker J., Automotive Management, 2013, ISBN: 978-3486723328
- Lotko A., Korneta P., Lotko M., Longwic R. Using Neural Networks in Modeling Customer Loyalty in Passenger Cars Maintenance and Repair Services. Applied Sciences 8 (5), 2018. https://www.researchgate.net/publication/324947465_Using_Neural_Networks_in_Modeling_Customer_Loyalty_in_Passenger_Cars_Maintenance_and_Repair_Services
- Lotko A., Lotko M., Longwic R. Different Multidimensional Exploratory Techniques in Classifying Variables Into Qualitative Criteria of Spare Parts Selection for Passenger Cars, ASTRJ 10, 2016. https://pdfs.semanticscholar.org/6f6c/f392e51bcc8946a1c5782cd2284edd60e14a.pdf?_ga=2.168201633.108205843.1588599824-1201586086.1588599823
- Lotko M., Lotko A., Qualitative Attributes of Spare Parts for Passenger Cars and the Characteristics of the Vehicle and its Maintenance. Arch. Automot. Eng. 72 (2), 2016. https://pdfs.semanticscholar.org/cb81/e126594f6bf55ebe2b03125903552467b636.pdf

Language Lessons (Greek)

Teaching Period	Course Code
First Term	TS1.11

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6				3	1

Language	Lecturer
Greek	International Hellenic University (IHU)

Prerequisites

The course is indented for adult speakers interested in learning Greek as a second language. Participation in the Greek language course does not require any pre-existing knowledge, as students will be introduced to the A1 level of language learning.

Content (Syllabus Outline)

According to the Common Framework of Reference for Languages, adult participants in this course will acquire the basic skills of Greek (understanding and using oral and written discourse) as well as its socio-linguistic features so as to be able to respond in simple communication situations. In particular, they will focus on issues related to their personal and everyday life (identity, accommodation, simple communication in their social relationships, nutrition, education, transportation and travel). In order to promote interculturalism, during the course will present the main parts of the history of Greek culture and will be presented and visits to museums and cultural sights of the city of Thessaloniki (e.g. Byzantine Museum of Thessaloniki, Castles etc.) will be carried out.

Objectives and Competences

- Understand and use Greek language in a basic level, in order to respond in a variety of everyday communication situations
- Learn about Greek history and culture, especially the culture of Thessaloniki

Intended Learning Outcomes

At the end of the Language Lessons TS1.11 course, the participants will be able to understand and use at a basic level the Greek language in relation to several communication topics. They will be able to understand and use everyday expressions that they are familiar with and very basic phrases aimed at meeting specific needs. They will be able to introduce themselves as well as ask and answer questions about personal information, such as where they live, about their interests etc. In terms of intercultural competence, the participants will be able to socialize and interact

with other Greek participants in the program or in highly predictable everyday communication events by using a basic level of Greek language. Additionally, they will be able to name and briefly describe local historical sights and places in Thessaloniki.
Specifically, they will be able to understand and provide information about:

1. their personal data,
2. themselves and others,
3. their accommodation,
4. traffic and travelling,
5. education and knowledge of languages.

Learning and Teaching Methods

The learning and teaching methods used in this course will be based on learner needs and will thus be learner-centred and personalized. The teaching approach will follow the premises of communicative language teaching, with focus placed on the pragmatic and sociolinguistic competence. In-class lectures (6 hours) will be supported by online material designed for individual learning and consolidation of knowledge. Online lectures will be designed by presentations.

Assessment

Assessment will be task-based according to the objectives of the course. The participants will prepare and present information about themselves in Greek language (e.g.: a description of him/her, his / her education, accommodation etc.).
The course ECTS credits are awarded to all students after completion of the learning activities and the successful assessment of the achieved learning outcomes, that is if the assessment is graded by a minimum of 5/10.
Assessment = Homework Task (100%)

Basic Literature

- Karakour*giou, M. & Panagiotidou, B. (2014). Click on Greek level A1 for teens and adults. Basic user.* Thessaloniki: Center for Greek Language. (ISBN: 9789607779649)
- Agathos, Th., Galantomos, I., Inzidis, B., Karantzola, E., Roubis, N. & Simopoulos, G. (2010). *Learning the Greek language, A1 / A2.* Athens: Institute for Adult Continuing Education, Program Odysseus: education of immigrants in Greek language, Greek history and Greek culture. (ISBN: 978-960-7335-43-2)
- Online: http://www.gsae.edu.gr/attachments/article/803/%CE%92%CE%99%CE%92%CE%9B%CE%99%CE%9F%20%CE%911.pdf
- Pathiakis, Eir., Simopoulos, G., Kanellopoulou, R. & Pavlopoulou, Ag. (2010). *Greek I - Method of learning Greek as a foreign language*. Athens: Patakis. (ISBN: 9789601652856)
- Abbati, A., Dallas, M., Rizikova, E., Sekertzis, K., Toura, K. & Toutoudaki, A. (2000/2003). *Together, Student's Book 1/2, Greek as a Second Language, Intensive Lessons for Children and Young People*. Athens: National and Kapodistrian University of Athens, Center for Intercultural Education. Online: https://www.keda.uoa.gr/epam/pdf/high/mazi.pdf
- Abati, A., Dimitrakou, S., Iakovou, M., Kavvada, A., Mangana, A., Bella, Sp., Dallas, M., Sekertzi, K., Toura, K. & Toutoudaki, A. (2003). *Language Case: Greek as a Second Language,*

Grammar and Exercises for Children and Young People. Athens: National and Kapodistrian University of Athens, Center for Intercultural Education. (ISBN: 960-8313-69-4) Online: http://reader.ekt.gr/bookReader/show/index.php?lib=EDULLL&item=822&bitstream=822_01#page/8/mode/2up

- Tzamali, K. & Skounaki, I. (2013). *Elements of Greek history and Greek culture.* Ministry of Education and Lifelong Learning. (ISBN: 978-960-7335-48-7)
- Skourtou, E. & Kourtis-Kazoulis, B., (2015). *Bilingualism and teaching Greek as a second language.* Athens: SEAV. (ISBN: 978-960-603-480-0).

Intermediate Project 1

Teaching Period	Course Code
First Term	TS1.12

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
				36	

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

All other courses of TS1

Content (Syllabus Outline)

Intermediate Project 1 is mentioned in time slot 1 of the overall educational procedure; however it will concern the participating students right after the end of the courses of time slot 1. Particularly, the students will be divided in international groups and will have the obligation to deal with a subject related to the courses of time slot 1, appropriately selected by all teachers. A tutor will be assigned to each group of students in order to assist them complete their project. The project will require the utilization of the NI products in order to produce a scaled automotive control system based on the NI LabVIEW software, for example, a replica autonomous EV, transferring goods from one place to another through a specific pathway. A descriptive manuscript, a possible experimental structure and a small presentation will be the deliverables of each project group. Each intermediate project will have to be delivered by the beginning of the courses of time slot 2.

Objectives and Competences

The objective of the specific course, which is basically laboratorial, is to enhance the gained knowledge of the students on the subjects taught in time slot 1 and integrate knowledge acquired during the overall educational program, through the utilization of the NI products in order to produce a scaled automotive control system based on the NI LabVIEW software.

Intended Learning Outcomes

Students that will perform the specific project, will be able

- to determine the essential requirements for the solution of an automotive engineering problem
- to calculate the parameters required to produce a problem solution

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- to satisfactorily present a simple LabVIEW program
- to design and develop an automotive control system for a scaled vehicle

Learning and Teaching Methods

The working hours of the students will be devoted to laboratory occupation for the preparation of their deliverables. Student tutors will play a supervisory role.

Assessment

The students will be assessed in groups according to the quality of their deliverables.

Basic Literature

All educational material provided in the frame of the other TS1 courses.

Electric Vehicle System Modelling and Simulation

Teaching Period	Course Code
Second Term	TS2.1

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6		9		3	1

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

TS1.2 NI LabVIEW Training

Content (Syllabus Outline)

The first part of the lecture covers preliminary issues such as dynamic modeling in engineering applications, the use of differential equations in dynamic models, mathematical description of models in the field of time and frequency, non-linear models and their linearization. The second part will discuss the example of a dynamic model, its implementation in a computer program, simulation and discussion of simulation results.

Systems that have been studied in previous courses are presented in simple mathematical terms and then converted into simple models. This applies to systems such as power supply, vehicle dynamics, energy management.

Objectives and Competences

Objectives

- to provide the students with the necessary knowledge about mathematical modelling the systems, especially systems of EVs

Competencies

- to simulate models of the system with software package
- to understand and appropriate interpret the simulation results

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe a simulation model of a system
- to demonstrate what a system simulation model is
- to satisfactorily present the results of a system's simulation

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- to develop the model of a given system and perform a computer simulation based on it

Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Experimental exercises
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory report, analyzing and commenting on the experimental results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- LabVIEW 2018 Control Design and Simulation Module Help: http://zone.ni.com/reference/en-XX/help/371894J-01/
- Tutorial: Getting Started with Simulation: http://zone.ni.com/reference/en-XX/help/371894J-01/
- Kai Velten: Mathematical Modelling and Simulation, Introduction for Scientists and Engineers. https://mcdtu.files.wordpress.com/2017/03/velten-mathematical-modeling-and-simulation.pdf
- An Introduction to Mathematical Modelling: https://people.maths.bris.ac.uk/~madjl/course_text.pdf
- Komorska I.: Adaptive model of engine vibration signal for diagnostics of mechanical defects, MECHANIKA Wyd. Kaunas University of Technology, 2013 Volume 19(3): 301-305 http://mechanika.ktu.lt/index.php/Mech/article/view/4658
- Komorska I.: Vibroacoustic diagnostic model of the vehicle drive system. Monograph. Ed. by ITE-PIB, Radom Poland 2011 https://www.researchgate.net/publication/276047647_Adaptive_model_of_engine_vibration_signal_for_diagnostics_of_mechanical_defects
- Komorska I.: Automobile Gearbox Diagnostics on the Basis of the Reference Model, Mechanics and Control, Vol.31 No.1 2012 s. 6-15. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-article-AGHS-0006-0002

Electric Vehicle Energy Storage Systems

Teaching Period	Course Code
Second Term	TS2.2

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6		6		3	1

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR) eProInn - Inteligg PC (INT)

Prerequisites

TS1.1 Introduction to Vehicle Electrification
TS1.2 NI Labview Training
TS1.3 Automotive Energy Sources

Content (Syllabus Outline)

Complete electric vehicle energy storage system comprised of sources accordingly mentioned in course TS1.3 "Automotive Energy Sources", like accumulators, ultracapacitors and fuel cells form the subject of the course. The fundamental characteristics of accumulators and ultracapacitors as well as their basic parameters like voltage, capacity, state of charge, state of health, specific power etc are analyzed and case studies are mentioned. Special discussion is made on battery management systems, power management of the complete energy storage system and DC/DC and DC/AC converters.

Objectives and Competences

The objectives of this course is the student

- to be in the position to learn and understand the different EVs energy storage systems and Competences
- understand the material, methods, rules that will be able to give him/her a flexibility to encounter and exercise later this knowledge

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe various automotive energy sources in an energy storage system
- to categorize the basic macroscopic parameters of an energy source
- to calculate the range of a vehicle based on existing energy sources
- to satisfactorily present a complete EV energy storage system

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- to analyze an EV energy storage system based on desired vehicle performance

Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Laboratory experiments
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory Reports, describing the laboratory experiments and corresponding results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- 'Electrical Energy Storage for Transport and Stationary applications', IKERLAN-IK4, Report https://www.researchgate.net/publication/261117628_Analysis_and_comparison_of_battery_energy_storage_technologies_for_grid_applications
- 'The economics of using plug-in hybrid electric vehicle battery packs for grid storage', Journal of Power Sources, Volume 195, Issue 8, 15 April 2010, Pages 2377-2384. https://www.sciencedirect.com/science/article/abs/pii/S0378775309017303
- 'Battery, Ultracapacitor, Fuel Cell, and Hybrid Energy Storage Systems for Electric, Hybrid Electric, Fuel Cell, and Plug-In Hybrid Electric Vehicles: State of the Art', IEEE Transactions on Vehicular https://ieeexplore.ieee.org/document/5446335
- 'Electrochemical Energy Storage for Green Grid', doi.org/10.1021/cr100290v | Chem. Rev. 2011, 111, 3577–3613. https://pubs.acs.org/doi/full/10.1021/cr100290v
- 'Battery energy storage technology for power systems—An overview', Electric Power Systems Research 79 (2009) 511–520 https://www.sciencedirect.com/science/article/abs/pii/S0378779608002642

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Electric Vehicle Charging Systems

Teaching Period	Course Code
Second Term	TS2.3

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
21	3	6		12	4

Language	Lecturer
English	International Hellenic University (IHU) eProInn – Ezee Europe (EZEE) Hellenic Institute of Transport (HIT)

Prerequisites

TS1.1 Introduction to Vehicle Electrification

TS1.2 NI Labview Training

TS1.3 Automotive Energy Sources

Content (Syllabus Outline)

The course is closely connected with the energy storage system one. It deals with the characteristics of the most popular electric vehicle charging systems. Technologies found in private and public charging stations, normal and fast chargers are analyzed. Charging time, charging capacity and of course charging cost are among the addressed subjects of the course. Installation demands and policies are further discussed. The course will also involve experiments performed on real world charging infrastructures.

Objectives and Competences

Competences:

- Knowledge on the studied material and the corresponding technology that will provide the student with the capacity to learn new methods and theories and further versatility to be adapted in new situations.

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe basic EV charging system
- to demonstrate the properties of charging systems and the differences between various types
- to calculate the charging times based on battery and charging system characteristics

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- to satisfactorily present parts of a charging system and its connection with EVs
- to analyze and design an appropriate charging system for given vehicle and desired charging times

Learning and Teaching Methods

Teaching face to face
Webinars and Web based lectures in general
E-learning support (use of asynchronous e-learning platform)
Laboratory experiments
Compulsory homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory Reports, describing the laboratory experiments and corresponding results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- 'BATTERY CHARGERS: POTENTIAL ENERGY EFFICIENCY OPTIONS', Paul Ryan, Director, Energy Consult Pty Ltd, Report. https://www.energyrating.gov.au/sites/default/files/documents/E3-Product-Profile-Battery-Chargers_0.pdf
- https://www.tuv.com/greater-china/en/electric-vehicle-charging-system-testing.html
- http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1996-15.pdf
- Lecturer's own teaching/research material

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Mechanical Drivetrains for Electric Vehicles

Teaching Period	Course Code
Second Term	TS2.4

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
9		4		4.5	1.5

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

Students are recommended to have acquired basic knowledge of "Mathematics" as well as "Fundamentals of vehicle design" or/and "Fundamentals of machine component design".

Content (Syllabus Outline)

The course on mechanical drivetrain for electric vehicles (EVs) is focused on the below listed topics:

1. Introduction to drivetrains&powertrains to electric (EV) and hybrid vehicles (HEV).
2. The mechanical drivetrain structure elements and architectures of HEV and EV.
2. Drivetrains of electric bikes.
3. Gear boxes used in selected EVs.
4. Fundamental calculations of drivetrains used in EVs.
5. Internal Combustion Engines for Hybrid Electric Vehicles.
6. Range extenders for electric vehicles.
7. Laboratory testing of vehicles drivetrains.

Objectives and Competences

The main objective of the following course is to teach students how to apply mechanical drivetrain theory in engineering practice. Particular emphasis will be given to providing support for training of future engineers equipped with value-added fundamental skills beneficial for automotive industry.

Intended Learning Outcomes

Upon completion of the subject on Mechanical Drivetrains for EVs students will be able to:

- recognize and describe a basic mechanical drivetrain structure and parts
- analyze the operation of mechanical parts of a drivetrain,
- calculate the required parameters in order to create a simple mechanical drivetrain,
- present a complete mechanical drivetrain,
- analyze a mechanical drivetrain based on given performance and parts,
- measure vehicle drivetrain performance on a chassis dynamometer.

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Learning and Teaching Methods

Conventional lecture/discussion sessions supported by the multimedia presentation and resources of the e-learning platform. Exercises carried out by international students divided into smaller groups. Compulsory homework focused on the impact of gear box parameters on the vehicles performance. Practical laboratory

Assessment

The performance of the individual student is assessed taking into account the ECTS grades and weighting factors (WF) of: final examination (WF 50%), homework (WF 25%), laboratory report (WF 25%). The course ECTS credits are awarded to all students after completion of the learning activities and the successful assessment of the achieved learning outcomes,
that is if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (50%) + Homework (25%) + Lab (25%)

Basic Literature

- Olszewski M. Evaluation of 2004 Toyota Prius HED System. U.S. Dept. of Energy 2005, https://www.engr.uvic.ca/~mech459/Pub_References/890029.pdf
- Masrur A. et al. Hybrid Electric Vehicles with Practical Perspectives. Wiley, 2011, ISBN: 978-1-118-97056-0
- Soylu S. Electric Vehicles. The Benefits and Barriers. InTech 2011, ISBN: 978-953-307-287-6
- Heisler H. Advanced Vehicle Technology. Butterworth-Heinemann. 2002, ISBN: 9780750651318
- Ehsani M. et al. Modern Electric, Hybride Electric, and Fuel Cell Vehicles. CRC 2005, ISBN 0-8493-3154-4
- Guzzella L., Sciarretta A. Vehicle Propulsion Systems. 2nd edition. Springer 2007, ISBN 978-3-642-35912-5
- Górski K. Smigins R.: Selected Physicochemical Properties of Diethyl Ether/Rapeseed Oil Blends and Their Impact on Diesel Engine Smoke Opacity. Energy&Fuels. 32(2), 2018. https://pubs.acs.org/doi/full/10.1021/acs.energyfuels.7b03225?src=recsys
- Skrzek T. Effect of diesel fuel injection parameters on performances and efficiency of a turbocharged dual-fuel compression ignition engine operating on propane. IOP 2018(421), https://iopscience.iop.org/article/10.1088/1757-899X/421/4/042073/pdf
- Asok K.Sen, Longwic R., Litak G., Górski K.: Analysis of cycle-to-cycle pressure oscillations in a diesel engine. Mech Syst Signal Process. 22(2), 2008. https://www.researchgate.net/publication/223214093_Analysis_of_cycle-to-cycle_pressure_oscillations_in_a_diesel_engine

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Control System Development

Teaching Period	Course Code
Second Term	TS2.5

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
9		6		4.5	1.5

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

Students are recommended to have acquired Basic knowledge of electric machines and Fundamentals of control systems

Content (Syllabus Outline)

The course aims to introduce to students the basics of control systems used for EVs operation. It will mainly cover motor control schemes (speed and torque) for basic electric machines used in EVS. First the students will be introduced to the fundamentals of motor control also presenting relevant models. Then various control strategies (e.g. FOC, DTC etc) will be elaborated. Students will also be introduced to principles of sensorless techniques. Non linear control concepts (e.g. fuzzy logic) will also be presented.

Objectives and Competences

- Develop students' knowledge of motor control principles
- Understand principles of operation of speed and torque control systems
- Develop practical skills in machines control

Intended Learning Outcomes

Students that will successfully attend the course will be able to:

- recognize and describe the structure of an automotive control system
- develop simple control algorithms
- calculate the parameters required to control the operation of an automotive actuator
- satisfactorily present an automotive control system
- analyze, design and experimentally develop essential closed loop control systems

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Learning and Teaching Methods

The course is delivered in the form of in-class lectures, lab experiments and exercises and mini-projects (H/W)

Assessment

The performance of the individual student is assessed taking into account the ECTS grades and weighting factors (WF) of: final examination (WF 50%), homework (WF 25%), laboratory report (WF 25%). The course ECTS credits are awarded to all students after completion of the learning activities and the successful assessment of the achieved learning outcomes,
that is if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (50%) + Homework (25%) + Lab (25%)

Basic Literature

- Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Pearson ISBN-13:978-0-13-602458-3
- Bimal K. Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, https://www.semanticscholar.org/paper/Power-Electronics-And-Variable-Frequency-Drives-And-Kazmierkowski/e2ece06ea38a57e206b183746c37e8b94d42a55b

Electric Vehicle Public Policies

Teaching Period	Course Code
Second Term	TS2.6

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6				3	1

Language	Lecturer
English	Inteligg PC (INT)

Prerequisites

TS1.4 Lightweight materials
TS2.2 EV Energy Storage Systems

Content (Syllabus Outline)

The course focuses on the specific reasons that prevent electric vehicles from wide spreading and the policies implemented worldwide in order to overcome this problem. A significant part of the course is the legislation around the EU regarding the purchase, use, charging and disposal of EVs. In this frame, innovation policies, implemented by either the state or private domain in order to promote EV production, EV research and development, development of EV infrastructure and finally EV consumption will be explored.

Objectives and Competences

The objectives of this course is the student

- to be in the position to learn and understand the different EVs policies in EU and globally and
- to be in the position to categorize them by himself the different available paths followed by each country individually and then as a whole either in case of EU or globally.

Competences

- understand the material, methods, rules that will be able to give him/her a flexibility to encounter and exercise later this knowledge

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and categorize the reasons that prevent EV's widespread
- to present an EV promoting policy
- to analyze existing public policy to promote EVs

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- to develop an EV promotion public policy

Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Compulsory homework

Assessment

The students will be assessed in two ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions. Weighting Factor: 25%
2. Homework in the form of a group project evaluating current and suggesting possible alternative paths, appointed to students in small groups or personal. Weighting Factor: 75%
The course ECTS are granted to the students if both parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (25%) + Homework (75%)

Basic Literature

- Reports, publications and Statistics from European Automobile Manufacturers Association (ACEA) will be provided to the students showing the different EV policies, legislation and existing selling of EVs in the different European countries. In parallel different scientific publications showing the possible advantages-disadvantages of current EVs policies globally will be provided to the students so that in this way will have a clear picture of what are the current trends in the EV industry.
- https://www.acea.be/statistics/article/interactive-map-electric-vehicle-incentives-per-country-in-europe-2019
- 'Policy Instruments to Promote Electro-Mobility in the EU28: A Comprehensive Review', Sustainability 2018, 10, 2507; doi:10.3390/su10072507
- https://www.transportenvironment.org/sites/te/files/publications/Emobility%20Platform%20AFID%20analysis.pdf

Electric Vehicles and Smart Gridding

Teaching Period	Course Code
Second Term	TS2.7

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6				3	1

Language	Lecturer
English	Inteligg PC (INT) Hellenic Institute of Transport (HIT)

Prerequisites

TS1.7 EV Production Management
TS2.2 EV Energy Storage Systems
TS2.3 EV Charging Systems

Content (Syllabus Outline)

The course will provide the students with knowledge regarding the current trends in power supply and charging of electric vehicles. EVs will no longer be encountered as standalone equipment requiring charging but as entities of an entire charging network that must cooperate with other entities in order to serve their own power supply requirements but also respect and serve the characteristics of the entire network. Theoretical techniques and algorithms, together with significant case studies will also be presented.

Objectives and Competences

The objectives of this course for the student are:

- understand the different interactions that take place between the EVs and the corresponding smart grid

Competences:

- understand the material, methods, rules that will be able to give him/her a flexibility to encounter and exercise later this knowledge

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to recognize and describe public power supply network (grid) structure
- to analyze the basics of smart gridding
- to satisfactorily present the various roles of an EV on a potential smart grid

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Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Compulsory homework

Assessment

The students will be assessed in two ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions. Weighting Factor: 50%
2. Homework in the form of a group project evaluating current and suggesting possible alternative paths, appointed to students in small groups or personal. Weighting Factor: 50%
The course ECTS are granted to the students if both parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (50%) + Homework (50%)

Basic Literature

The literature will be different scientific journals that will be provided to the students and will be related with the topic of EVs and Smart Grids interactions. Representative journals could be: IEEE Transactions on Smart grids, IEEE Transactions on Electrification on Transportation, etc. as below

- Francis Mwasilu, Jackson John Justo, Eun-Kyung Kim, Ton Duc Do, Jin-Woo Jung, 'Electric vehicles and smart grid interaction: A review on vehicle to grid and renewable energy sources integration', Renewable and Sustainable Energy Reviews, 34 (2014) 501–516. https://doi.org/10.1016/j.rser.2014.03.031
- https://ec.europa.eu/energy/sites/ener/files/documents/metis_s13_final_report_electromobility_201806.pdf
- Lecturer's own teaching/research material

EV on Board Diagnostics, troubleshooting and Maintenance

Teaching Period	Course Code
Second Term	TS2.8

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6		3		3	1

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

TS1.2 NI LabVIEW Training,
TS1.6 Data Acquisition and EV Sensors

Content (Syllabus Outline)

The course will be a mixture of theoretical knowledge and practical implementation, as it will provide the students insight to the world of on board diagnostics (OBD) for EVs and HEVs and troubleshooting. OBD is a universally implemented methodology by all automotive manufacturers to find, locate and repair a fault in a vehicle. The students will meet the most important diagnostic tools in an automotive store. The theoretical part of the course will also include guidelines on EV maintenance, specifically on the EV battery pack. Significant part of the course is the corresponding laboratory session.
Contents: Understanding On-Board Diagnostics. Information networks in vehicles. CAN in vehicle – electrical parameters, types, protocol, faults. Faults in Electric Vehicles. Electric Vehicles Maintenance. Diagnostic Tools for Electric Vehicles. Diagnostic tests, troubleshooting procedures.

Objectives and Competences

Objectives

- to provide the students the necessary knowledge connected with the maintenance, fault detection and troubleshooting of the EVs

Competences

- to connect with the CAN Bus protocol architecture to send & receive data
- to troubleshoot common ECU faults from defective sensors & sub-systems

Intended Learning Outcomes

Students that will successfully attend the course will be able:

- to recognize and describe an EV fault
- to implement On-board Diagnostics in EVs
- determine an EV maintenance procedure

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- to estimate faults of the electric vehicle power network
- to satisfactorily present a fault in electric vehicle and its solution
- to analyze and develop an EV troubleshooting procedure

Learning and Teaching Methods

Teaching face to face
E-learning support (use of asynchronous e-learning platform)
Experimental exercises
Compulsory homeworks

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory report, analyzing and commenting on the experimental results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab (30%)

Basic Literature

- Johansson K.H., Torngren M., Nielse L.: Vehicle Applications of Controller Area Network. https://people.kth.se/~kallej/papers/can_necs_handbook05.pdf
- CAN-Automotive Diagnostic Command Set User Manual, http://www.ni.com/pdf/manuals/372139d.pdf
- Corrigan, Steve: Introduction to the Controller Area Network (CAN).Texas Instruments, 2008. http://www.ti.com/lit/an/sloa101b/sloa101b.pdf
- Puchalski A., Komorska I.: Online Fault Diagnosis of Automotive Powernets by Kalman Filtering, Key Engineering Materials, Vol. 588, 209-213, Trans Tech Publication Inc. , 2014 https://www.scientific.net/KEM.588.209
- Komorska I., Wołczyński Z., Borczuch A.: Model-based analysis of sensor faults in SI engine, Combustion Engines 2/2017 (169), s.146-151 http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-649d5449-3e04-4b52-8add-a2d56584ebab
- Jabłoński A., Komorska I.: Data analysis in the CAN bus at the didactic position (In Polish), Autobusy. Technika, Eksploatacja, Systemy Transportowe 6/2017, s. 749-751 http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-c7dce613-171a-4e72-9c46-d461e1d39363/c/134_069_EiT_JABLONSKI_KOMORSKA.pdf

Life Cycle Assessment of Electric Vehicles

Teaching Period	Course Code
Second Term	TS2.9

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
3		2		1.5	0.5

Language	Lecturer
English	Hellenic Institute of Transport (HIT) EZEE Europe (EZEE)

Prerequisites

None

Content (Syllabus Outline)

The course is an introduction to the theory of life-cycle assessment (LCA) of electric vehicles. The students will get acquainted with the environmental impact of electric vehicles taking into account the manufacturing, use and end-of-life phases of the vehicles, as well as the energy used. Special software packages will be used in order to calculate the LCA of electric vehicles, having as main tool the well-to-wheel analysis, which measures the overall emissions from the production of electricity to the wheels of the vehicle.

Objectives and Competences

The course provides the student with knowledge about:

- Life Cycle Assessment (LCA) framework for evaluation of the environmental footprint of EV systems and related technologies;
- Application of Life Cycle Assessment on energy, product & transport technologies and systems;
- How to assess the environmental performance of energy and systems.

Intended Learning Outcomes

Students that will successfully attend the course will be able to:

- describe the idea of life cycle assessment
- use the essentials of electric vehicle life cycle assessment
- calculate life cycle of electric vehicle energy sources based of LCA methodology
- satisfactorily present the assessment about an electric vehicle's life cycle
- to perform a simple life cycle analysis

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Learning and Teaching Methods

- Teaching face to face
- Webinar and web-based teaching
- e-learning support (use of asynchronous e-learning platform)
- Laboratory experiments
- Team essays / homework

Assessment

The students will be assessed in three ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions. Weighting Factor: 40%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%
3. Laboratory Reports, describing the laboratory experiments and corresponding results. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (40%) + Homework (30%) + Lab(30%)

Basic Literature

- Electric vehicles from life cycle and circular economy perspectives. TERM 2018: Transport and Environment Reporting Mechanism (TERM) report, EEA, Denmark, 2018, ISSN 1977-8449. https://www.eea.europa.eu/publications/electric-vehicles-from-life-cycle/download
- Energy Efficiency and Conservation Authority. Life Cycle Assessment of Electric
- Vehicles, Final Report, 243139-00, Australia, November 2015. https://apo.org.au/sites/default/files/resource-files/2015-11/apo-nid58940.pdf
- eLCAr: Guidelines for the LCA of electric vehicles. Technical Report, January 2013. https://www.researchgate.net/publication/291135663_eLCAr_Guidelines_for_the_LCA_of_electric_vehicles

Sustainable Transportation

Teaching Period	Course Code
Second Term	TS2.10

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
3				1.5	0.5

Language	Lecturer
English	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

TS1.1 Introduction to Vehicle Electrification
TS2.2 Automotive Energy Sources
TS2.5 Control System Development

Content (Syllabus Outline)

The assumptions of sustainable transport are discussed during the lecture:
Control of emissions of harmful compounds present in exhaust gases and -in the long term- transition from means of the transport based on fossil fuels to vehicles using renewable energy.
Reducing the scale of destruction of urban space as a result of the dominance of individual road transport.
Development and promotion of bicycle communication and public transport, promotion of walking and group travel, construction of carshare systems.
Reduction of emissions and waste, consumption of renewable resources in quantities that can be reproduced, consumption of non-renewable resources in quantities that can be replaced by renewable substitutes.
Sustainable electromobility is studied in the frame of zero accidents, zero pollution and zero traffic jams.

Objectives and Competences

To provide the students with the necessary knowledge related to the new planning paradigm of sustainable transportation.

Intended Learning Outcomes

Students that will successfully attend the course will be able

- to analyze the term of sustainability in the automotive area
- to satisfactorily present the sustainability of electric power sources

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- to analyze the new planning paradigm of sustainable transportation in the automotive area and the sustainability of electric power sources

Learning and Teaching Methods

Problem lecture
E-learning support

Assessment

The students will be assessed in two ways:
1. Final written exams, assessing the students through exercises solution and multiple choice questions, theoretical and practical. Weighting Factor: 70%
2. Homework(s), appointed to students in small groups or personal. Weighting Factor: 30%

The course ECTS are granted to the students if all parts of the assessment are graded by a minimum of 5/10.
Assessment = Exam (70%) + Homework (30%)

Basic Literature

- Preston L. Schiller, Jeffrey R. Kenworthy, An Introduction to Sustainable Transportation: Policy, Planning and Implementation, Routledge, 2018, ISBN: 978-1138185487
- Jeffrey Tumlin, Sustainable Transportation Planning: Tools for Creating Vibrant, Healthy, and Resilient Communities, Wiley 2012, ISBN: 978-0-470-54093-0
- Puchalski A. et al, Synthesis of naturalistic vehicle driving cycles using the Markov Chain Monte Carlo method, Maintenance and Reliability, Vol.22 (2), 2020, https://www.researchgate.net/publication/339966596_Synthesis_of_naturalistic_vehicle_driving_cycles_using_the_Markov_Chain_Monte_Carlo_method
- Puchalski A. et al, Multifractal analysis vehicle's in-use speed profile for application in driving cycles, Maintenance and Reliability, Vol. 20 (2), 177–181, 2018, http://ein.org.pl/sites/default/files/2018-02-02.pdf
- Puchalski A., Komorska I.,Binomial multifractal features of worldwide harmonized light duty vehicles test cycle. Vibroengineering PROCEDIA, Vol. 13, 175 179, 2017, https://www.jvejournals.com/article/19074

Language Lessons (Polish)

Teaching Period	Course Code
Second Term	TS2.11

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
6				3	1

Language	Lecturer
Polish	Kazimierz Pulaski University of Technology and Humanities in Radom (UTHR)

Prerequisites

No prior knowledge of the Polish language is required.

Content (Syllabus Outline)

The course on language lessons (Polish) is focused on the below listed topics:
1. Basic knowledge concerning the Polish alphabet.
2. Greetings and farewells.
3. Transportation in Poland. Phrases needed at the bus or train station.
4. Introducing oneself – name, nationality and hobby.
4. Numbers, days of the week, months, telling the time.
5. Giving and asking about contact details such as emails, address and telephone number.
6. Useful Polish phrases to use in a restaurant (Polish traditional dishes and drinks).

Objectives and Competences

The main objectives of the following course are:
- acquiring basic vocabulary,
- learning basic conversational patterns,
- using basic grammatical structures,
- gaining some cultural insight concerning Poland.

Intended Learning Outcomes

Students that will successfully attend the course on fundamentals of the Polish language will be able to:
- gain introduction to a new language,
- acquire basic language skills for conversing, reading and writing.

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Learning and Teaching Methods

Lecture/discussion sessions supported by the multimedia presentation and resources of the e-learning platform. Compulsory homework carried out in international teams supported by Polish native students.

Assessment

The performance of the individual student is assessed taking into account the ECTS grades and weighting factors (WF) of: final examination (WF 40%), homework (WF 40%), active participation (WF 20%). The course ECTS credits are awarded to all students after the completion of the learning activities and the successful assessment of the achieved learning outcomes.
Assessment = Exams (40%) + Homework (40%) + Participation (20%)

Basic Literature

Sources for learning Polish presented below:

- Swan O.E. Polish Grammar In a Nutshell. http://www.skwierzyna.net/polishgrammar.pdf
- Polish language website. Univ. of Pittsburgh. https://lektorek.org/lektorek/
- Barrera M., Becerra B. Polish Culture, Traditions and Language Manual. TSUC 2012, http://languagemanuals.weebly.com/uploads/4/8/5/3/4853169/polish.pdf
- https://www.clozemaster.com/blog/best-resources-for-learning-polish/
- https://fsi-languages.yojik.eu/languages/FSI/Polish/FAST/FSI%20-%20Polish%20FAST.pdf

Intermediate Project 2

Teaching Period	Course Code
Second Term	TS2.12

Lectures In-class	Lectures Web	Lab Exercises	Practice	Home Work	Exams
				36	

Language	Lecturer
English	International Hellenic University (IHU)

Prerequisites

All other courses of TS1 and TS2.

Content (Syllabus Outline)

Intermediate Project 2 will play a similar role in the educational procedure as Intermediate Project 1, link Time Slot 1 courses with Time Slot 2 ones. The students will have to develop simple Augmented Reality (AR) code based on the NI products provided by the partner institutions. The AR code will be used by the *Developing Tool Demonstration* course. The code will be simple enough as developing blank geometrical drawings in the AR space. Similarly with Intermediate Project 1, a tutor will be assigned to each group of students in order to assist them complete their project. A descriptive manuscript, the AR code and a small presentation will be the deliverables of each project group. Each intermediate project will have to be delivered by the beginning of the practical experience period.

Objectives and Competences

The objective of the specific course, which is basically laboratorial, is to enhance the gained knowledge of the students on the subjects taught in time slot 2 and integrate knowledge acquired during the overall educational program, through the development of Augmented Reality and Hololens technology code.

Intended Learning Outcomes

Students that will perform the specific project, will be able

- to recognize and describe the basic instructions of the AR programming language
- to determine the elementary structure of an AR code
- to satisfactorily present a simple AR code
- to analyze, design and develop an AR code creating simple geometrical drawings

Learning and Teaching Methods

The working hours of the students will be devoted to laboratory occupation for the preparation of their deliverables. Student tutors will play a supervisory role.

Assessment

The students will be assessed in groups according to the quality of their deliverables.

Basic Literature

All educational material provided in the frame of the other TS1 and TS2 courses.