UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

COURSE SYLLABUS 2017-2018

GENERAL INFORMATION

Course information	
Name	Automotive Electronics
Code	DEA-OPT-446
Degree	IEM
Year	4th
Semester	2nd (Spring)
ECTS credits	3 ECTS
Type	Elective
Department	Electronics, Automation and Communications
Area	Electrical Engineering
Coordinator	Romano Giannetti

Instructor	
Name	Vicente de Las Heras Banon
Department	Robert Bosch España S.L.U
Area	
Office	D-219bis (Despacho DEAC)
e-mail	Vicente.de-las-heras@es.bosch.com
Phone	91 3279214
Office hours	Arrange an appointment through email.

Instructor	
Name	
Department	
Area	
Office	
e-mail	
Phone	
Office hours	

DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

The aim of this course is to introduce the modern electronic devices and systems with applications in automotive electronics industry. The underlying physics of devices, their functional characteristics, fabrication technologies, design of the electronic devices and systems will be covered.

This course provides an overview of the electronic systems found in automotive designs including critical systems, navigation, sensoring, interfacing, safety systems and communication systems. The course also reviews trends in automotive electronics as well as issues (such as production techniques, cost, reliability and systems integration) that are driving the industry with a couple of visits to the Bosch industrial plant and laboratories included. As a result, they will be able to develop electronic systems for the car industry or third party industries in which a solid background in the topic is often requested.

Prerequisites

Fundamentals of Electronics (analogue and digital circuits). Digital Electronics Systems, Control Engineering.

CONTENTS

Contents
SECTION 1: Automotive Electronics Fundamentals
This section aims to fundamentals to electronics in vehicles.
T1: Introduction to Automotive Engineering
1.1 Overview of vehicle electronic systems **1.2** Review the trends in automotive electronics as well as issues that are driving the automotive industry.
T2: Fundamentals of Automotive Electronics
2.1 Integration of electronic components and systems in vehicles. **2.2** Embedded processors and microcontrollers. **2.3** Interfaces to peripherals and to sensors
SECTION 2: Electronic Systems
This section introduces specific and basic electronics on board vehicles.
T3: Automotive Communications Systems
3.1 Introduction to communications standards. **3.2** Introduction to networks, safety critical issues and reliability. **3.3** Communication protocols for automotive application. CAN, LIN Bus and others. **3.4** Telematics for automotive applications. **3.5** GPRS, GPS for use in and automotive environment.
T4: Automotive Control and Power Systems
4.1 Electronic control methods (analogue and digital). **4.2** Stability algorithms for control (cruise control, traction control). **4.3** Actuator limiting, wind-up, gain scheduling and others. **4.4** Energy management strategies: regenerative breaking, start-stop, torque boost. **4.5** Sensing and control systems. Interfacing using power devices.
T5: Sensors and Interfacing
5.1 Introduction to electronic instrumentation for sensors: temperature, distance, velocity, speedometer, anti-collision and others. **5.2** Interfacing electronics with Operational Amplifiers. **5.3** DA/AD converters, limitations, topologies and processing for sensors.
SECTION 3: Safety and Security Systems
This section addresses safety and security systems electronics
T6: Automotive Security: Active and Passive Systems
6.1 Introduction to security systems, from passive to active. **6.2** Passive system electronics: Airbag and sensors **6.3** Active systems electronics: Antilock-breaking system (ABS), Electronic Stability Program (ESP), Anti-slip regulation (ASR) and others
T7: Driver Assistance Systems
7.1 Advanced active systems electronics: ACC
7.2 Active safety system applications: lane detection, blind spot, crash avoidance control electronics.
T8: Production Techniques
8.1 Overview of the Manufacturing process for ultrasound and airbag sensors. **8.2** Quality management

T9: Automotive Diagnostics Techniques.
9.1 Diagnosis evolution **9.2** Parameter monitoring **9.3** Functional test **9.4** Central unit programming **9.5** Diagnosis SW and HW
T10: Visit (2) to Bosch Industrial Automotive Factory and Laboratories

Competences and Learning Outcomes

Competences

General Competences

CG2	The ability to manage activities of engineering project described in CG1 skills.
CG3	The capability of adapting to new theories, methods and changing engineering situations based on a sound technical training.
CG4	The capability of solving problems with personal initiative, efficient decision making, critical reasoning and transmitting technical information in the engineering world.
CG5	The capability of conducting measurements, calculations, assessments, studies, reports, planning, etc.
CG10	The ability to work in a multilingual and multidisciplinary environment.

Basic Competences

Specific Competences

Learning outcomes

By the end of the course students should be able to:

RA1. Understand the concept and the use of the electronics in the automotive engineering.
RA2. Understand electronic circuits and microcontrollers for control systems.
RA3. Understand main sensors and interfaces using in car industry.
RA4. Understand the Electronic Control Unit (ECU).
RA5. Know the communication systems in the automobile.
RA6. Understand the use of electronic system in the automotive safety.
RA7. Understand the use of the assistance driver electronic systems.
RA8. Understand the manufacturing process of the specific sensors.
RA9. Understand the test and diagnosis methodology in the car´s electronics.

TEACHING METHODOLOGY

General methodological aspects	
The best way of gaining a full understanding of computer vision techniques is implementing them and facing real challenges. Consequently, all the proposed activities focus on providing students with the tools they require to be able to successfully develop a computer vision application by the end of the term.	
In-class activities	**Competences**
▪ **Lectures and problem-solving sessions (15 hours)**: The lecturers will introduce the fundamental concepts of each chapter, along with some practical recommendations, and will go through worked examples to support the explanation. Active participation will be encouraged by raising open questions to foster discussion and by proposing short application exercises to be solved in class either on paper or using a software package.	CG5, CG3
▪ **Practice sessions (12 hours):** Under the instructor's supervision, students, divided in small groups, will apply the concepts and techniques covered in the lectures to real problems and will become familiar with the electronics on vehicles "in-situ" in the Bosch Factory. Practice attendance is mandatory. Besides, students will organize team-works in order to present a short technical session focus on new car technology.	CG4, CG2, CG10
▪ **Tutoring** for groups or individual students will be organized upon request.	–
Out-of-class activities	**Competences**
▪ Personal study of the course material and resolution of the proposed exercises (24 hours).	CG5, CG3
▪ Practice session preparation to make the most of in-class time (3 hours).	CG5
▪ Practice results analysis and report writing (9 hours).	CG5, CG11
▪ Development of a technical project in team-works during the last third of the course (24 hours).	CG4, CG2, CG10

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Weight
Mid-term exam/quizes	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving. ▪ Critical analysis of numerical exercises' results.	30%
Final exam	▪ Understanding of the theoretical concepts. ▪ Application of these concepts to problem-solving. ▪ Critical analysis of numerical exercises' results.	40%
Technical project	▪ Problem analysis. ▪ Information search skills. ▪ Quality of the proposed solution. ▪ Teamwork. ▪ Oral presentation and written communication skills. ▪ There will be an intra-group evaluation method to differentiate among team members.	30%

GRADING AND COURSE RULES

Grading

Regular assessment

- **Theory** will account for 70%, of which:
  - Mid-term & quizes: 30%
  - Final exam: 40%
- **Tech Project** will account for the remaining 30%, of which:
  - Oral and technical evaluation: 60%
  - Short paper project: 40%

In order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the mark of the project must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Retakes

Project marks will be preserved, if it has a passing grade. Otherwise a new project will have to be developed and handed in. In addition, all students will take a final exam. The resulting grade will be computed as follows:

- Final exam: 60%
- Project: 40%

As in the regular assessment period, in order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the mark of the final project must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

Course rules

- Class attendance is mandatory according to Article 93 of the General Regulations (Reglamento General) of Comillas Pontifical University and Article 6 of the Academic Rules (Normas Academicas) of the ICAI School of Engineering. Not complying with this requirement may have

the following consequences:

- Students who fail to attend more than 15% of the lectures may be denied the right to take the final exam during the regular assessment period.
- Regarding laboratory, absence to more than 15% of the sessions can result in losing the right to take the final exam of the regular assessment period and the retake. Missed sessions must be made up for credit.

Students who commit an irregularity in any graded activity will receive a mark of zero in the activity and disciplinary procedure will follow (cf. Article 168 of the General Regulations (Reglamento General) of Comillas Pontifical University).

WORK PLAN AND SCHEDULE[1]

In and out-of-class activities	Date/Periodicity	Deadline
Mid-term exam	Week 6	
Final exam	May	
Practical sessions	Weeks 7 and 14	TBD
Review and self-study of the concepts covered in the lectures	After each lesson	–
Problem-solving	Weekly	–
Presentation project	Weeks 12 and 13	Week 5
Final exam preparation	April	–

STUDENT WORK-TIME SUMMARY			
IN-CLASS HOURS			
Lectures	**Problem-solving**	**Practical sessions**	**Assessment**
14	4	8	4
OUT-OF-CLASS HOURS			
Self-study	**Student work on quizes**	**Team work**	**Final project**
24	12	8	16
		ECTS credits:	**3 (90 hours)**

[1] A detailed work plan of the subject can be found in the course summary sheet (see following page). Nevertheless, this schedule is tentative and may vary to accommodate the rhythm of the class.

BIBLIOGRAPHY

Basic bibliography

- Notes prepared by the lecturer (available in Moodle).
- Robert Bosch Gmbh 2013, *Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive*. Publication Date: July 31, 2013 ISBN-13: 978-3658017835. 6th Ed.

Complementary bibliography

- James D. Halderman. 2013. Advanced Automotive Electricity and Electronics. Prentice Hall.
- Williams B. Ribbens, 2012. Understanding Automotive Electronics. Seventh Edition, Elsevier Åström, Wittenmark. Computer Controlled Systems. 3rd ed. Prentice Hall, 1997
- S. Krueger, W.Gessner 2002, Advanced Mycrosystems for Automotive Applications. Springer
- Tom Denton 2004, Automobile Electronic & Electronic Systems, 3rd edition Ed.
- Link to others books http://www.cvel.clemson.edu/auto/info/books.html

	IN-CLASS ACTIVITIES				OUT-OF-CLASS ACTIVITIES				LEARNING OUTCOMES
Week	h/w	LECTURE & PROBLEM SOLVING	Practical session	ASSESMENT	h/w	SELF-STUDY	PREPARATION AND REPORTING	OTHER ACTIVITIES	Learning Outcomes
1	2	Course presentation (1h), Introduction to car industry- Bosch (1h)			1	Review and self-study (1h)			RA1
2	2	Basic car´s electronics (2h)			3	Review, self-study and problem-solving (3h)			RA1, RA2
3	2	Communications systems (2h)			3	Review, self-study and problem-solving (3h)			RA4, RA5
4	2	Sensoring in vehicles (2h)			3	Review, self-study and problem-solving (3h)			RA3
5	2	Control engineering (2h)			3	Review, self-study and problem-solving (3h)			RA1, RA2, RA3, RA4
6	2	Driver assistance systems (2h)			3	Review, self-study and problem-solving (1.5h)			RA6, RA7
7	2		Automotive Diagnosis (4 hs). Bosch		4		Prac preparation (1h) and report writing (3h)		RA7, RA8
8	2			Mid-term exam (1h)	8	Review and self-study (7.5h)			RA1, RA2, RA3, RA4, RA5
9	2	Automotive microcontrollers (1h) Racing sensors and testing (1h)			4	Review, self-study and problem-solving (3h)		Project proposal (1h)	RA4, RA5
10	2		Team work presentation (2H)		5	Review, self-study and problem-solving (3h)		Project & paper (4h)	RA1, RA2, RA3, RA4, RA5, RA6
11	2		Team work presentation (2H)		8		Lab preparation (1h) and report writing (3h)	Project & paper (4h)	RA1, RA2, RA3, RA4, RA5, RA6
12	2		Team work presentation (2H)		4			Project & paper (4h)	RA1, RA2, RA3, RA4, RA5, RA6
13	2	Sensor production and Quality (2h)			3	Review, self-study and problem-solving (3h)			RA1, RA2, RA3, RA4, RA5, RA6
14	2		Sensor production and Quality (4h) Bosch		4		Prac preparation (1h) and report writing (3h)		RA1, RA2, RA3, RA4, RA5, RA6
15	2				4			Final exam preparation (4h)	RA1, RA2, RA3, RA4, RA5, RA6