COURSE INFORMATON					
Course Title	*Code*	*Semester*	*C +P + L Hour*	*Credits*	*ECTS*
Sensors	EE515	Winter and/or Spring	3 + 0 + 0	3	10

Prerequisites	All Bach. Basics of Electrical and Electronics Engineering recommended

Language of Instruction	English
Course Level	Master's and Doctorate
Course Type	Elective
Course Coordinator	Fethi Olcaytuğ
Instructors	Fethi Olcaytuğ
Assistants	
Goals	Overview of technical sensor groups, their application examples and fabrication techniques in classical and micro-systems technologies.
Content	Key definitions and terminology, an overview of the general field of sensors with typical examples and their applications will be presented. Basics of thermodynamics, temperature, radiation force and pressure sensors, inertial, magnetic and flow sensors will be explained in more detail. Position and angular sensors, few actuator applications and the field of chemo-, gas- and biosensors will be touched briefly. Foundations on basic theory, conversion principles, sensitivity and measurement ranges, cross-sensitivities, materials related aspects, technical realization, manufacturing technologies, relevance of industrial sensor packaging and bonding, generation, conditioning and electronic interfacing, micro-miniaturization techniques, challenges of the field applications will be covered.

Learning Outcomes	**Program Outcomes**	**Teaching Methods**	**Assessment Methods**
1) Technical sensing, sensor as tool, inspirations by Bionics	1,2,3,4,5,6	1,2	A,B,D
2) Select, apply, optimize, existing sensor types for specific engineering tasks	1,2,3,4,5,6	1,2	A,B,D
3) Perform relating sensor signal conditioning matched to the given sensorics task	1,2,3,4,5,6	1,2	A,B,D
4) Create a potential for developing ideas towards novel sensor types and conversion principles	1,2,3,4,5,6	1,2	A,B,D
5) Create abilities for thinking about novel technologies for sensor realization	1,2,3,4,5,6	1,2	A,B,D

Teaching Methods:	1: Lecture, 2: Problem Solving, 3: Simulation, 4: Seminar, 5: Laboratory, 6: Term Research Paper

Assessment Methods:	A: Exam, B: Quiz, C: Experiment, D: Homework, E: Project

COURSE CONTENT		
Week	**Topics**	**Study Materials**
1	Introduction with Selected Examples of Sensor Applications	Lecture Notes
2	Brief Rewiev of the Basics of Thermodynamics and of the Key Terminology for Sensors	Lecture Notes
3	Definitions of Temperature, Thermoelectric Effects, Seebeck-Effect, Metallic and Semiconducting Thermocouples	Lecture Notes
4	Peltier-Effect in Metalls and Semiconductors, Applications of the Seebeck and Peltier Effects	Lecture Notes
5	Midterm-Exam-1 , Metal Resistance Thermometers, Semiconductor Basics	Lecture Notes
6	NTC Thermistors, Semiconductor Thermometers, Piezo-Resistive Effect	Lecture Notes
7	Midterm-Exam-2, Force Sensors, Metallic Strain Gauges,	Lecture Notes
8	Piezo-Resistive Effect in Semiconductors, Stress-Strain Relation in Crystalline Materials, Semiconducting Force Sensors	Lecture Notes
9	Pressure Sensors, Application Examples, Microtechnological Realization, Basics of Inertial Sensors	Lecture Notes
10	Acceleration Sensors, Gear Rate Sensors	Lecture Notes
11	Introduction to Magnetic Sensors, Magnetoresistive Effects	Lecture Notes
12	Magnetoresistive Sensors, Applications, Hall Effect, Hall Sensors, Applications	Lecture Notes
13	Giant Magnetoresistive Effect and its Applications, Flow Sensor Principles	Lecture Notes
14	Technical Realization of Flow Sensors, Electrochemical Sensors	Lecture Notes

RECOMMENDED SOURCES	
Textbook	Lecture Notes
Additional Resources	Books: Sze, Semiconductor Sensors, Publishing House VCH Middelhoek, Silicon Sensors, TU Delft Gardner, Microsensors, Wiley Göpel, Sensors Vol. 1 to n, Publishing House VCH Fraden Jacob, Handbook of Modern Sensors : Physics, Designs, and Applications, 2004 Soloman Sabrie, Sensors handbook, McGraw-Hill, New York 2010 Journals: Sensors and Actuators A: Physical (Elsevier)

MATERIAL SHARING	
Documents	Course Web Page (Coadsys)
Assignments	Course Web Page (Coadsys)
Exams	Course Web Page (Coadsys)

ASSESSMENT		
IN-TERM STUDIES	**NUMBER**	**PERCENTAGE**
Midterm I	1	20
Midterm II	1	20
Homework Assignment	1	20
Total		**60**
CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE		40
CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE		60
Total		**100**

COURSE CATEGORY	Field Course

COURSE'S CONTRIBUTION TO PROGRAM							
No	Program Learning Outcomes	Contribution					
		1	2	3	4	5
1	Can reach information in breadth and depth, and can evaluate, interpret and apply this information to scientific research in the area of Electrical and Electronics Engineering.				X	
2	Can complete and apply information with scientific methods using limited or missing data; can integrate information from different disciplines.					X
3	Sets up Electrical and Electronics Engineering problems, develops and implements innovative methods for their solutions.					X
4	Develops new and/or original ideas and methods; finds innovative solutions to the system, component, or process design.					X
5	Has comprehensive knowledge about the state-of-the-art techniques and methods in Electrical and Electronics Engineering and their limitations.				X	
6	Can design and conduct research of analytical, modeling or experimental orientation; can solve and interpret complex cases that come up during this process.				X	
7	Can communicate verbally and in writing in one foreign language (English) at the General Level B2 of the European Language Portfolio.			X		

8	Can assume leadership in multi-disciplinary teams; can develop solutions in complex situations, and take responsibility.				X	
9	Can systematically and openly communicate in national and international venues the proceedings and conclusions of the work he/she performs in Electrical and Electronics Engineering.				X	
10	Respects social, scientific and ethical values in all professional activities performed during the collection, interpretation and announcement phases of data.				X	
11	Is aware of new and emerging applications in Electrical and Electronics Engineering; investigates and learns them, whenever necessary.					X
12	Can identify the social and environmental aspects of Electrical and Electronics Engineering applications.				X	

ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION			
Activities	Quantity	Duration (Hour)	Total Workload (Hour)
Course Duration (including 2 midterms: 14xtotal lecture hours)	14	3	42
Hours for off-the-classroom study (Pre-study, practice)	14	10	140
Midterm I	1	7	7
Midterm II	1	7	7
Homework assignment	1	35	35
Final examination	1	15	15
Total Work Load			**246**
Total Work Load / 25 (h)			9,84
ECTS Credit of the Course			**10**