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ELEC 390 Independent Study – Fall 2022

Course instructor: Dr. Mehmet Cengiz Onbaşlı (SNA Z30, extension: 1711, monbasli@ku.edu.tr)
Course student: Kaan Ataberk Yılmaz (ID: 0069511, email: kyilmaz18@ku.edu.tr)
Course meeting location: SNA Z30 (the instructor's office)
Course meeting times: TBD, 1 hour/2 weeks in weeks 1, 3, 5, 7, 9, 11, 13 (final presentation)

Course Description
This course introduces advanced sensing concepts and analyzes example commercial sensor datasheets. Starting from the advanced introduction to sensors, concepts that apply to all sensors such as signal to noise ratio, dynamic range, calibration, sensitivity, specificity, error and noise types, and operational modes are covered. Next, sensing mechanisms, materials and device designs for measuring spatial variables (displacement, velocity, acceleration, thickness, angular velocity and orientation, location, volume), time and frequency, mechanical variables (mass, weight, strain, force, torque, pressure, sound pressure level), temperature, thermal conductivity, electrical properties (voltage, current, power, electric field, magnetic field, inductance, capacitance, conductivity), optical properties (spectroscopy, refractive index, optical loss, polarization, image, video) and chemical properties (composition, pH, humidity, environmental parameters). The power source design and their topologies, voltage and current regulation methods are studied in detail. Constraint-driven design principles for embedded sensing and measurement systems are investigated and applied with the course project.

Course Objectives
By the end of the course, the student should be able to:
1) identify sensor mechanisms for measuring any physical stimulus
2) design embedded power supply circuit based on the environment restrictions
3) apply the fundamentals of constraint-driven design.
4) apply the hardware and software design principles for embedded systems.

Course textbooks
1) J.G. Webster ed., *The Measurement, Instrumentation and Sensors Handbook,* CRC Press, 1999, ISBN: 084932145X
2) Texas Instruments Power Topologies Handbook: online link
3) Texas Instruments, Fundamentals of Power Supply Design: online link

Teaching Methods
Biweekly meetings include student and instructor presentations, textbook and datasheet reading and presentation assignments, questions and answers, discussion, design reviews, experimental demonstrations and an applied hardware and software project.

Course Schedule

Weeks	Description (bold items are graded assignments)
Week – 1	Advanced sensor introduction: SNR, dynamic range, calibration, sensitivity, specificity, error and noise types, operational modes, 3 sensor datasheet examples
Week – 2	Advanced sensor concepts: accuracy, confusion matrix (true positives/negatives, false positives/negatives), measurement standards, 3 sensor datasheet examples
Week – 3	linear displacement, angular rotation, thickness, proximity, position, location and altitude measurements, 3 sensor datasheet examples **Assessment meeting 1 and student presentation**
Week – 4	Sensing level, area, volume, tilt, velocity, acceleration, vibration, and shock measurements, time and frequency measurements, 3 sensor datasheet examples
Week – 5	Sensing mechanical variables (mass, weight, strain, force, torque, pressure, sound pressure level), temperature, thermal conductivity, 3 sensor datasheet examples **Assessment meeting 2 and student presentation**
Week – 6	Measuring electrical properties (voltage, current, power, electric field, magnetic field, inductance, capacitance, conductivity), 3 sensor datasheet examples
Week – 7	Measuring optical properties (spectroscopy, refractive index, optical loss, polarization), 3 sensor datasheet examples **Assessment meeting 3 and student presentation**
Week – 8	Image sensors categories, cameras and video recording, 3 sensor datasheet examples
Week – 9	Measuring chemical properties (composition, pH, humidity, environmental parameters), 3 sensor datasheet examples **Assessment meeting 4 and student presentation**
Week – 10	The power source design and their topologies, voltage and current regulation methods, power IC datasheet examples
Week – 11	The power source design and their topologies, **Assessment meeting 5 and student presentation**
Week – 12	voltage and current regulation methods, power IC datasheet examples
Week – 13	Constraint-driven design principles for embedded sensor systems **Assessment meeting 6 and student presentation**
Finals week	**Assessment meeting 7 and student project final presentation**

Assessment Methods

Type	Description	Grade (%)
Assessment Meetings	Bi-Weekly meetings and presentations to assess the student's project progress and learning*	28 (7 presentations, 4 points each)
Final Project	Design project (oral and written presentation)**	72
	TOTAL	100

*** See the presentation rubric and template for biweekly presentations.**
**** See the oral presentation rubric and written presentation rubric for grading details.**

Course policies

1) Academic dishonesty is subject to disciplinary action as per student's code of conduct: Student Code of Conduct | Academic Planning and Development Directorate
2) Missing more than 4 assessment meetings without excuse causes letter grade F (failure from the course).