San Jose State University
Mechanical Engineering Department

ME284 Sensor Technology and Principles
Fall 2018

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Office Hours MW: 9:30-10:00 AM; M: 3:45-4:15 PM; 5:50-6:20 PM; M: (E310F or E192)

Course Schedule ME284-01 (47416) Seminar; 3 Units; MW 16:30-17:45; Room E192

Course Description

Principles and design of *Resistive, Capacitive, Inductive, and Magnetic* (RCIM) sensors that comprise more than 70% of sensor market today. Their applications in automobiles/aviation, bioengineering research, disease diagnoses, environmental monitoring, quality control, home automation, and homeland security. Sensor circuitry and signal conditioning. Case studies to explore state-of-the-art sensor technologies. Invited speakers to share their first-hand experience in sensor design and manufacturing. Term projects to apply the knowledge gained from this class to design practical and functional sensors.

Prerequisite BSME or consent of instructor

Textbook *Resistive, Capacitive, Inductive, and Magnetic Sensor Technologies*
Winncy Y. Du, Taylor & Francis Group, CRC Press, 2015, ISBN 978-1-4398-1244-0

Grading Scheme

Homework	18%
Case Study Presentation & Report	7%
Midterm Exams 1 and 2 (15% each)	30 %
Term Project	20 %
Final Exam	25 %

A+	95-100	A	90-94.9	A-	87-89.9				
B+	85-86.9	B	80-84.9	B-	77-79.9				
C+	75-76.9	C	70-74.9	C-	67-69.9				
D+	65-66.9	D	60-64.9	D-	57-59.9		F	<57	

Case Studies

2-4 students, as a team, to identify/explore one latest sensor product (not necessary to be RCIM sensors, or hybrid, or sensor array, or a unique sensor circuit/package). The team will study the sensor product first, and then present it to the class on one of the case study days. During the presentation, it is very important to address, besides other features, why the sensor is unique compared to other latest products. You can present the sensor physically (ideal) or photos/videos. Two or three groups can present their findings in each case study day/class.

Term Project

Each team (2-4 students) will design and fabricate one of RCIM sensors, or a hybrid sensor, or a sensor array. Term project proposal, report, presentation, and demonstration are required.

Student Conduct Codes

- Turn off iPhones during the lecture
- Be in the classroom on time.
- Attend every scheduled lecture, case study, term project presentation, and exam.
- Turn in homework at the beginning of the class on the due day. Each homework will be assigned on Wednesday, and it will be due on the following Wednesday. Each student is only allowed to miss one homework for whatever reasons. No late HW will be accepted.

- Avoid distractions. Food and drink are not allowed during lectures.

Course Goals

To ensure students

- master the most important RCIM sensor principles in measuring variety of physical quantities (e.g., temperature, displacement, velocity, acceleration, force, pressure, concentration, flowrate, sound level, light density, radiation level, magnetic field strength) and obtaining biological information (e.g., concentration on oxygen, CO, CO_2, glucose, acetone).
- understand the primary properties/characteristics of RCIM sensing elements and transducers, their operating requirements, and suitable applications
- know the role of the bridge circuits and signal conditioning circuits in sensor design and function
- be familiar with RCIM sensor design and fabrication
- be exposed to the latest technologies, smart systems, and innoviations that impact advanced sensors.

Student Learning Objectives

Upon successful completion of the course, the student should be able to

- know how to read sensor manufacturing data sheet and how to choose a right sensor
- explain the principles, design, and applications typical RCIM sensors
- perform basic calculation and mathematical analysis of RCIM sensors
- state the basic structure, performance, and operation requirements of primary RCIM sensors
- describe elementary electronic components and their functions in sensor circuitry
- interpret sensor signal conditioning (noise attenuation, amplification, filtering)
- know how to integrate a sensor with other devices (microcontrollers, actuators, and other sensors)
- design and build an RCIM sensor
- state major sensor materials, their characteristics, and measurement ranges
- understand the MEMS sensors, their fabrication techniques and major processes.

Academic Integrity

Your commitment as a student to learning is evidenced by your enrollment at San Jose State University. The University's Academic Integrity policy, located at http:// www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/. Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person's ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all HW assignments are to be completed by the individual student unless otherwise specified.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

Student Technology Resources

Computer labs for student use are available in the Academic Success Center located on the 1st floor of Clark Hall and on the 2nd floor of the Student Union. Additional computer labs in Mechanical Engineering Department are located in E213/215. Computers are also available in the Martin Luther King Library. A wide

variety of audio-visual equipment is available for student checkout from Media Services located in IRC 112. These items include digital and VHS camcorders, VHS and Beta video players, 16 mm, slide, overhead, DVD, CD, and audiotape players, sound systems, wireless microphones, projection screens and monitors.

Learning Assistance Resource Center

The Learning Assistance Resource Center (LARC) is located in Room 600 in the Student Services Center. It is designed to assist students in the development of their full academic potential and to inspire them to become independent learners. The Center's tutors are trained and nationally certified by the College Reading and Learning Association (CRLA). They provide content-based tutoring in many lower division courses (some upper division) as well as writing and study skills assistance. Small group, individual, and drop-in tutoring are available. Please visit the LARC website for more information at http://www.sjsu.edu/larc/.

SJSU Writing Center

The SJSU Writing Center is located in Room 126 in Clark Hall. It is staffed by professional instructors and upper-division or graduate-level writing specialists from each of the seven SJSU colleges. Our writing specialists have met a rigorous GPA requirement, and they are well trained to assist all students at all levels within all disciplines to become better writers. The Writing Center website is located at http://www.sjsu.edu/ writingcenter/about/staff/.

Peer Mentor Center

The Peer Mentor Center is located on the 1st floor of Clark Hall in the Academic Success Center. The Peer Mentor Center is staffed with Peer Mentors who excel in helping students manage university life, tackling problems that range from academic challenges to interpersonal struggles. On the road to graduation, Peer Mentors are navigators, offering “roadside assistance” to peers who feel a bit lost or simply need help mapping out the locations of campus resources. Peer Mentor services are free and available on a drop –in basis, no reservation required. The Peer Mentor Center website is located at http://www.sjsu.edu/muse/peermentor/

Student Success and Wellness

Attending to your wellness is critical to your success at SJSU. I strongly encourage you to take advantage of the workshops and programs offered through various Student Affairs Departments on campus such as Counseling Services, the SJSU Student Health Center/ Wellness & Health Promotion Dept., and Career Center. See http://www.sjsu.edu/ wellness or http://www.sjsu.edu/counseling/Workshops/ for workshop/events schedule and links to many other services on campus that support your wellness! You may go to http://events.sjsu.edu to register for any one of the workshops.

Tentative Course Schedule

WEEK #	**TOPICS**
Week #1 08/22	Course syllabus, pre-requisites, permit codes; course overview and structure
Week #2 08/27, 08/29	Ch.1 (1.3.2-1.3.14) TF, sensitivity, linearity, SNR, precision, calibration, bandwidth
Week #3 09/05	Ch.2 (2.2-2.4) potentiometric, temperature sensors
Week #4 09/10, 09/12	Ch.2 (2.4 and 2.5) photoresistive, piezoresistive sensors; BJT ransistor control circuits
Week #5 09/17, 09/19	Ch. 2 (2.7) chemoresistive, bioresistance/impedance sensors Ch.3 (3.2-3.4) capacitive sensor related physical laws/effects; parallel capacitive sensors
Week #6 09/24, 09/26	Ch.3 (3.5-3.7) cylindrical & spherical capacitive sensors; capacitive sensor arrays ***Case Study 1: Resistive Sensors*** Course Project information and guideline
Week #7 10/01, 10/03	Review for Exam #1 **Exam 1 (Ch.1 & 2)** Ch.4 (4.3-4.5) inductance related physical laws/effects, sensor types and materials
Week #8 10/08, 10/10	Ch.4 (4.6) air coil, ferromagnetic cores, transformers ***Case Study 2: Capacitive Sensors***
Week #9 10/15, 10/17	Ch.5 (5.2, 5.4) Hall & magnetostrictive sensors -- Invited speaker Ch.5 (5.3) magnetoresistive (AMR/GMR)
Week #10 10/22, 10/24	Ch.5 (5.5-5.6) NMR, MRI, Barkhausen sensors
Week #11 10/29, 10/31	***Case Study 3: Magnetic Sensors*** Ch.5 (5.7-5.8) Wiegand, magneto-optical sensors
Week #12 11/05, 11/07	Ch.6 (6.3-6.5) sensor noise, circuitry, grounding & shielding; DC bridge circuits Ch.6 (6.6-6.7) AC bridges, sensor output circuits
Week #13 11/14	**Exam 2** (Ch.3 & 4)
Week #14 11/19	Ch.6 (6.8-6.9) compensation circuits, signal conditioning, passive & active filters
Week #15 11/26, 11/28	***Case Study 4: Sensor Circuitry*** Term project work
Week #16 12/03, 12/05	Course project presentation, demonstration, and evaluation
Week #17 12/10	Course Review
Final Exam: 1445-1700, Thursday, December 13, E192	