SAN JOSÉ STATE UNIVERSITY
Charles W. Davidson College of Engineering
Department of Mechanical Engineering

ME/EE 106 - Fundamentals of Mechatronics Engineering Fall 2018

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Office Hours:	Tu 1330-1430, Th 1330-1430, or by appointment
Class Meeting Information	ME 106 Seminar 01 (47457): TuTh 1630 – 1720 WSQ 109 Lab 02 (47463): Tu 1330 -1615 E125 NOTE! First meeting on 08/28/18 Lab 03 (47464): Wed 1800 – 2045 E125 NOTE! First meeting on 08/29/18 Lab 04 (47465): Thurs 1330 -1615 E125 NOTE! First meeting on 08/30/18 Lab 05 (47466): Fri 1430 – 1715 E125 NOTE! First meeting on 08/31/18 Lab 06 (47467): Fri 0900 – 1145 E125 NOTE! First meeting on 08/31/18 EE 106 Seminar 01 (50096): TuTh 1630 – 1720 room WSQ 109 Lab 02 (50097): Tu 1330 -1615 E125 NOTE! First meeting on 08/28/18 Lab 03 (50098): Wed 1800 – 2045 E125 NOTE! First meeting on 08/29/18 Lab 04 (50099): Thurs 1330 -1615 E125 NOTE! First meeting on 08/30/18 Lab 05 (50100): Fri 1430 – 1715 E125 NOTE! First meeting on 08/31/18 Lab 06 (50101): Fri 0900 – 1145 E125 NOTE! First meeting on 08/31/18
Prerequisites:	EE 098 and ME 030 (or CS 49C OR CMPE 30 OR CMPE 46) or their equivalents (with a grade of 'C-' or better in each). For IT majors: TECH 060, MATH 071, CMPE 046 (with a grade of 'C-' or better in each).

Accessing Course Materials and Messaging

Copies of the course materials such as the syllabus, major assignment handouts, etc., may be found on the SJSU Canvas course management system: https://sjsu.instructure.com/courses/1265815 (see https://sjsu.instructure.com/) for more information). You are responsible for regularly checking for updates and reading messages that I may send to you through mySJSU, Canvas, Piazza, or other system.

Course Description

Introduction to mechatronics with emphasis on analog electronics, digital electronics, sensors and transducers, actuators, and microprocessors. Lectures are intended to provide the student with foundational concepts in mechatronics and practical familiarity with common elements making up mechatronic systems. Laboratory experiments are designed to give the student hands-on experience with components and measurement equipment used in the design of mechatronic products. (3 units; lecture/lab)

Course Goals and Learning Objectives

The goals of this course are to help you:

1. Develop an understanding of the basic elements underlying mechatronic systems: analog electronics, digital electronics, sensors, actuators, microcontrollers, and embedded software.
2. Understand how to interface electromechanical systems to microcontrollers.
3. Gain hands-on experience with commonly used electronic test and measurement instrumentation.
4. Improve written communication skills through laboratory and project reports.
5. Gain practical experience in applying knowledge gained in the course through a hands-on project.

Learning Objectives

The student who successfully completes the course will be able to:

1. Articulate what the essence of mechatronics is and provide examples of mechatronic systems.
2. Explain the concepts of input and output impedance, voltage division, and circuit loading
3. Explain the concept and characteristics of a signal source.
4. Design and analyze the performance of RC low-pass and high-pass filter circuits.
5. Explain the basic structure of a microcontroller, the nature of IO ports, and the common peripheral subsystems found in most microcontrollers.
6. Write embedded software to successfully interact with sensors, power interfaces, analog and digital IO ports, and other peripheral elements in the control of a mechatronic system.
7. Explain what analog-to-digital-conversion (A/D) is and how to implement it using a microcontroller.
8. Select and configure operational amplifier circuits to achieve desired interfacing requirements between a signal source and a downstream device such as a microcontroller or data acquisition system.
9. Explain the practical limitations of operational amplifiers and quantitatively estimate the effects of these limitations on output voltage and current of the op-amp.
10. Explain the basic operation of bipolar and MOS field-effect transistors and design with them to activate solenoids, relays, motors, etc. from signal sources.
11. Explain the input/output characteristics of digital logic devices and design a logic circuit to accomplish a given task.
12. Explain the underlying operational principles and construction of electromagnetic actuators such as DC, AC, and stepping motors.
13. Determine the torque and speed requirements for a given motion control application considering system inertia, external forces or torques, and motion profiles and select an appropriate motor.
14. Function effectively as part of a team in carrying out laboratory experiments and open-ended projects.
15. Document a laboratory experiment and open-ended projects clearly and completely in written form.

Text

Required Textbook

Carryer, J. E., Ohline, M., Kenny, T. (2011). *Introduction to Mechatronic Design*, Prentice Hall, New Jersey. ISBN: 978-0-13-143356-4.

Recommended Textbooks

Scherz, P., Monk, S. (2016). *Practical Electronics for Inventors 4th ed.*, McGraw-Hill, New York. ISBN: 978-1259587542. Some errors are noted here: http://tinyurl.com/yay232mv. If you get an earlier edition of this book, also consult the errata at: http://www.eg.bucknell.edu/physics/ph235/errata.pdf)

Required Hardware

Arduino microcontroller (UNO R3, but clones will work). Sources for these boards include: NKC Electronics , Adafruit Industries, Sparkfun Electronics, Modern Device, sainsmart (local sources: Jameco, Fry's Electronics), and many others. Ballpark price is $4 - $20. You will also need a WiFi enabled device, such as a smartphone, laptop, or tablet for in-lecture exams and quizzes. Such devices (including Arduinos) can be borrowed from Student Computing Services if you unable to obtain your own. See: http://library.sjsu.edu/student-computing-services/equipment-loans

Library Liaison

Our liaison to the University Library is Linda Crotty <linda.crotty@sjsu.edu>,
408-808-2633. Linda can help you make optimum use of information resources available to you through the University Library.

Classroom Protocol

I expect everyone to make their best effort to attend *all* class sessions and laboratory periods. Please arrive to the classroom or laboratory *before* the session begins, so that others are not disturbed by your entry after instruction has begun. If you normally keep a cell phone activated and with you, put your cell phone on 'vibrate' before you enter the classroom. Having your cell phone ring during class is disruptive, and will not be tolerated.

Dropping and Adding

Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. Information on add/drops are available at http://info.sjsu.edu/home/schedules.html. Information about late drop is available at http://www.sjsu.edu/aars/policies/latedrops/policy/ **.** Students should be aware of the current deadlines and penalties for adding and dropping classes.

Assignments and Grading Policy

Assessment for the purposes of determining your course grade will consist of evaluating your performance on homework assignments, laboratory reports, quizzes and examinations, projects, and the final examination.

Quizzes may take place in lecture and/or lab and may be unannounced (so keep up on your reading and studying for this class). Check the ME 106 Course Schedule listed below for links to the homework and laboratory assignments.

Homework will be submitted by upload to Canvas approximately one week after it is assigned. Late submissions *may* receive partial credit, but this will be at the discretion of the grader. All submissions must be clear and legible. If the grader cannot read what you have submitted, you will not receive credit for it.

Laboratory reports will handled similarly. Unless stated otherwise by your lab instructor, softcopy must be uploaded to the Canvas assignment one week after the laboratory experiment was performed.

The weighting of the course components and criteria for assigning letter grades are given below.

Weighting of Course Components for Determining the Course Grade

HW 10%, Lab Reports 20%, Project 20%, Midterm 10%, Quizzes 5%, Final Exam 20%, and Individual Performance on the Term Project 15%

Criteria for Assigning Letter Grades

The scores on your homework, laboratory reports, quizzes and exams, term project, final examination, and individual performance will be combined and totaled using the weighting scheme described above. A final letter grade will be determined from your overall performance (percentage) using the following criteria:
A 100 – 93%; A- 92 – 90%; B+ 89 – 87%; B 86 – 83%; B- 82 – 80%; C+ 79 – 77%; C 76 – 72%;
C- 71 – 69%; D+ 68 – 66%; D 65 – 62%; D- 61 – 59%; F <58%. Note: ME students must earn at least a grade of C- to pass the course.

The final examination for the course will be Friday, December 14, 2018 from 1445 - 1700 in room WSQ 109. You will need a WiFi enabled device, such as a smartphone, laptop, or tablet for the final exam. Such devices can be borrowed from Student Computing Services if you do not have your own. See: http://library.sjsu.edu/student-computing-services/equipment-loans for more information.

University Policies

Academic Integrity (This section is important, so make sure you read it! You will be held accountable to its stipulations.)

Your commitment as a student to learning is evidenced by your enrollment at San José State University. The University's Academic Integrity policy, located at http://www.sjsu.edu/studentconduct/docs/S07-2.pdf, 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 will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed *by the individual student* unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Plagiarism is defined as, *the use of another person's original (not common-knowledge) work without acknowledging its source*.[1] Examples of plagiarism include, but are not limited to[2]:

- copying in whole or in part, a picture, diagram, graph, figure, program code, algorithm, etc. and using it in your work without citing its source
- using exact words or unique phrases from somewhere without acknowledgement
- putting your name on a report, homework, or other assignment that was done by someone else

Students are expected to familiarize themselves with how to avoid plagiarism. Several helpful resources can be found at:

https://communitystandards.stanford.edu/student-conduct-process/honor-code-and-fundamental-standard/additional-resources/what-plagiarism

Note: I encourage students to collaborate on assignments, such as homework and lab reports, however what this means is that you can work together decide on solution *strategies*, discuss what should be included in reports and how they should be organized, etc., but you ***may not*** copy answers in whole or in part (this includes program code), and you must write your own lab reports. Unless otherwise specified, all assignments are to be completed by each student *individually*.

SJSU Senate Policy S12-3 - Federal Regulation of the definition of the credit hour:

Success in this course is based on the expectation that a student will spend, for each unit of credit, a *minimum* of 45 hours over the length of the course (normally three hours per unit per week with one of the hours used for lecture) for instruction or preparation/studying or course related activities including but not limited to internships, labs, clinical practica, etc. Other course structures will have equivalent workload expectations as described in the syllabus. [Thus, for this class, it is expected that you will spend *at least* seven hours outside of class working on homework, lab work, project work, test preparation, etc.] See: http://www.sjsu.edu/senate/docs/S12-3.pdf for more information.

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 AEC (Accessible Education Center) 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 are available for MAE students in E213 and E215. Computers are also available in the Martin Luther King Library (see: http://library.sjsu.edu/student-computing-services/equipment-loans).

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

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. Their 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/.

[1] Definition adapted from "Defining and Avoiding Plagiarism: The WPA Statement on Best Practices," http://wpacouncil.org/positions/WPAplagiarism.pdf; and "What is Plagiarism?" https://communitystandards.stanford.edu/student-conduct-process/honor-code-and-fundamental-standard/additional-resources/what-plagiarism.

[2] Adapted from: https://owl.purdue.edu/owl/research_and_citation/using_research/avoiding_plagiarism/is_it_plagiarism.html

Additional Notes:

- We will make extensive use of the Canvas course management system (https://sjsu.instructure.com/courses/1265815) and the Piazza Q & A platform. Make sure that you adjust your settings in Canvas and Piazza, so you will get notifications in a way that you check frequently. You will also need a WiFi enabled device (smartphone, tablet, or laptop) to bring to lecture, and a laptop or tablet computer to use for exams. If you don't have one of these devices, there are resources on campus that can loan you something appropriate. See: http://library.sjsu.edu/scs
- You will need to have access to an Arduino controller board for homework assignments. See the list of sources for where to buy a microcontroller on p. 2 of the syllabus.
- If you are going to be absent from class or lab, please give me a call, or send me an email as soon as you know that you will not be able to attend. Don't just not show up!
- Each reading assignment shown in the Course Schedule below should be completed ***prior to*** the lecture for the week in which the assignment is listed. In other words, read the assigned chapters before the next lecture! Doing so will help prepare you for lecture and will help you maximize your learning efficiency. It will also help you score well on any in-class quizzes on the readings. When you read, summarize the important points and jot down any questions that you have. Bring your questions with you to the lecture.
- The Course Schedule below also lists '*handouts'*, which are materials that we will use in lecture and that you would do well to bring with you to the lecture session. You can access the handouts along with the lecture slides in the Modules area of the course shell in Canvas.
- Following each lecture, I highly recommend that you ***review*** any notes you took in lecture along with the notes that you took from reading. Read back through your notes, and fill in any gaps that you may have missed or that became clearer from the lecture. Write down any questions you have in the margins of your notes. Be sure to come to office hours or ask about your questions in class.
- Please make it a point to ask questions in class, on Piazza, or in office hours whenever you don't understand something! If you don't, then you are essentially paying tuition for nothing! The pace of this class is relatively fast, especially if you have little prior experience with electronics or computer programming, so don't slack off.
- Start working on the project as soon as possible. The most common lament heard from students who fare poorly in the class is, "We should have started earlier on the term project."
- Lab experiments are intended to be performed in a group of ***two*** students. The laboratory report is to be written *individually*. It is acceptable to work *collaboratively* with your lab partner or other students in the class on the lab report, but it is **NOT** acceptable to copy someone else's report, in whole or in part. Examples of collaboration are: reviewing the data you gathered with your lab partner for consistency, jointly developing an outline of the key points to be included in the report, deciding together on the format and content of figures, etc. Examples of plagiarism are: copying and inserting sentences, paragraphs, or other text into your report that your lab partner or someone else wrote; copying figures or tables that your lab partner or someone else put together, etc. Software listings must be in machine readable form (not as an image).

References (ME 106 Course Reserves. In addition to these hardcopy references, check out the ME106 tutorial web pages)

Ball, S. (2003). *Analog Interfacing to Embedded Microprocessor Systems*, 2nd ed., Newnes, ISBN: 0750677236

Barnett, R., O'Cull, L., Cox, S. (2003). *Embedded C Programming and the Atmel AVR*, Delmar Learning, Clifton Park, NY.

Blum, J. (2013). Exploring Arduino: Tools and techniques for engineering wizardry. Indianapolis, IN. John Wiley & Sons. ISBN-13: 978-1118549360. https://www.exploringarduino.com/content/ch1/

Catsoulis, J. (2002). *Designing Embedded Hardware*, O'Reilly, ISBN: 0596003625

de Silva, C. W. (2010). Mechatronics: A Foundation Course, Taylor & Francis/CRC Press, Boca Raton, FL. ISBN: 978-1420082111.

Jones, J. L. & Flynn, A. M. (1998). *Mobile Robots: Inspiration to Implementation*, 2nd ed., A. K. Peters, Wellesley, Mass.

Ganssle, J. (1999). *The Art of Designing Embedded Systems*, Newnes, ISBN: 0750698691

Histand, M. B., Alciatore, D. G. (2007). Introduction to Mechatronics and Measurement Systems 3rd ed., WCB/McGraw-Hill, Boston. ISBN: 9780072963052.

Horowitz, P., Hill, W. (1989). *The Art of Electronics*, 2nd ed., Cambridge University Press, New York.

Labrosse, J. J. (1999). *Embedded Systems Building Blocks: Complete and Ready-To-Use Modules in C*, 2nd ed., CMP Books, ISBN: 0879306041

Margolis, M. (2011). *Arduino Cookbook*, 2nd ed., O'Reilly, Sebastopol, California. ISBN: 9781449313876. [Available as an eBook from the MLK Jr. Library]

McComb, G. (1987). *The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects*, Tab Books, Blue Ridge Summit, PA.

Mims, Forrest M. III. (1983). *Getting Started in Electronics* (Radio Shack cat. no. 62-5004), and his *Engineer's Mini-Notebook* series (particularly: Schematic Symbols, Device Packages, Design and Testing; Sensor Projects; 555 Timer Circuits; Optoelectronic Circuits), Radio Shack, Tandy Corp., Fort Worth, TX.

Pardue, J. (2005). *C Programming for Microcontrollers*, Smiley Micros, Knoxville, TN, www.SmileyMicros.com, ISBN: 0976682206.

Pont, M. J. (2001). *Patterns for Time-Triggered Embedded Systems: Building Reliable Applications with the 8051 Family of Microcontrollers*, Addison-Wesley, Harlow, England, ISBN: 0201331381.

Simon, D. E. (1999). *An Embedded Software Primer*, Addison-Wesley Professional, ISBN: 020161569X

Smaili, A. & Mrad, F. (2008). *Applied Mechatronics*, Oxford University Press, New York. ISBN: 978-0-19-530702-3

Stiffler, A. K. (1992). *Design with Microprocessors for Mechanical Engineers*, McGraw-Hill, New York.

Valvano, J. W. (2000). *Embedded Microcomputer Systems: Real Time Interfacing*, Thomson-Engin., ISBN: 0534366422.

COURSE SCHEDULE (approximate)

Wk.	Date	Subject
1	08/21-23	Enrollment, course organization, intro to mechatronics, review of basic electronics, Signal sources and their limitations;
Learning obj.		1, 2, 3, 4
Reading		Introduction to Mechatronic Design (IMD) text Chap 1; Chap 9: 9.1 – 9.7.1; 9.11 – 9.17 http://www.sjsu.edu/people/burford.furman/docs/me106/ME_may97_article.pdf http://academic.csuohio.edu/richter_h/courses/mce503/MEMag_June2008.pdf **Lecture Notes** (see Canvas): Day 1 – Course Intro and Basic Concepts and Basic Electronics Review
Lab		No lab this week! **Labs begin the week of 08/28/18** (next week). Next week in lab, you will learn to solder by building the Portmaster board. See Canvas Modules – Week 1 for Lab Prep Assignment!
Assignment		See Canvas Modules – Week 1!
2	08/28-30	RC filters; Discussion of term project
Learning obj.		3, 4
Reading		IMD Chap 9.8 – 9.9 **Lecture Notes**: Basic Electronics Review, Signal Sources, RC Filters, Notes on Lab 1 **Other materials:** (See Canvas Module): LM35 data sheet, Term Project Guidelines
Lab		Building the Portmaster Board (soldering exercise) See Canvas Module – Week 2
Assignment		Check Canvas!
Due		Check Canvas!

3	09/04-06	Microcontroller fundamentals, I/O ports, Arduino intro, Digital I/O
Learning obj.		5, 6
Reading		IMD Chap 2 and 3 Getting Started With Arduino (https://www.arduino.cc/en/Guide/HomePage) Skim the ATmega328 summary or full manual See especially the sections on, *Features*, *Configuration Summary*, *I/O Ports*, and *Electrical Characteristics* in the full manual. **Lecture Notes**: Introduction to the Arduino Controller **Other materials:** (See Canvas Module): Pin Map for the Arduino Controller, C Programming Review, Embedded and Arduinos vs. Standard C, Bit Manipulations, Bit Manipulations Addendum
Lab		Introduction to the Mechatronic Laboratory (See Canvas Module – Week 3)
Assignment		Check Canvas!
Due		Check Canvas!
4	09/11-13	Programming the Arduino
Learning obj.		5, 6
Reading		IMD Chap 5 and 6 **Lecture Notes**: Introduction to the Arduino Controller, Programming Microcontrollers, Embedded Programming **Handouts:** (See Canvas Module): Pin Map for the Arduino Controller, Bit Manipulations, Bit Manipulations Addendum, Blocking vs. Non-Blocking Code
Lab		Introduction to the Arduino Microcontroller (See Canvas Module – Week 4)
Assignment		Check Canvas!
Due		Check Canvas!
5	09/18-20	Diodes, transistors, using transistors to switch power to loads
Learning obj.		10
Reading		IMD Chap 10; 23.2 **Lecture Notes**: Interfacing to Control Power **Handouts:** (See Canvas Module): Transistor Action, Rectification and Simple Power Supplies, Summary of Diodes and Transistors. Also bring data sheets for 2N3904, 2N2222, TIP120
Lab		RC Filters (See Canvas Module – Week 5)
Assignment		Check Canvas!
Due		Check Canvas!
6	09/25-27	MOSFET's and power interfacing applications
Learning obj.		6, 10
Reading		IMD Chap 10 http://www.allaboutcircuits.com/vol_3/chpt_2/10.html http://www.fairchildsemi.com/an/AN/AN-7500.pdf **Lecture Notes**: Interfacing to Control Power **Handouts:** (See Canvas Module): Pinball flipper example, data sheets for: IRL520, IRF520, ULN2803, SN754410
Lab		Digital IO (See Canvas Module – Week 6)
Assignment		Check Canvas!
Due		Check Canvas!

7	10/2-4	Motor action, DC motors, drive system inertia calculation
Learning obj.		12, 13
Reading		IMD Chap 22 **Lecture Notes**: Actuators for Mechatronic Applications **Handouts**: (See Canvas Module): RC Servo Fundamentals, Motor Sizing Procedure, Motor Sizing Example Outline, Motor Sizing Example Calculations, Motion Control Mechanics
Lab		LEDs, Photoresistors, Transistors (See Canvas Module – Week 7) **Term Project Phase I Progress Review** (NOTE: counts for 10% of your Term Project grade!!!!)
Assignment		Check Canvas!
Due		Check Canvas!
8	10/9-11	Motor sizing, stepper motors
Learning obj.		12, 13
Reading		http://www.compumotor.com/literature/pdf/pg223_engrg_mtrsz.pdf **Lecture Notes**: Actuators for Mechatronic Applications **Handouts**: (See Canvas Module): Motion Control Mechanics, Motor Sizing Procedure, Motor Sizing Example Outline, Motor Sizing Example, Stepper Motors - Basic Operation and Construction, Stepper Motors - Practical Aspects Optional MicroMo DC motors tutorials http://www.cs.uiowa.edu/~jones/step/
Lab		Printer Carriage Motion Control (See Canvas Module – Week 8)
Assignment		Check Canvas!
Due		Check Canvas!
9	10/16-18	**Mid-term examination** (10/18), operational amplifiers, limitations of op-amps
Learning obj.		3, 8, 9
Reading		IMD Chap 11 and 12 **Lecture Notes**: TBD **Handouts:** (See Canvas Module): Op-amp Amplifiers, INA126 data sheet
Lab		Servo System Design (See Canvas Module – Week 9)
Assignment		Check Canvas!
Due		Check Canvas!
10	10/23-25	Comparators, signal conditioning; A/D and D/A conversion
Learning obj.		6, 7, 8, 9
Reading		IMD Chap 11.5; 19 **Lecture Notes**: Comparators, Digital-to-analog and analog-to-digital conversion **Handouts:** (See Canvas Module): Ladder DAC and Successive Approximation A/D Conversion, DAC/ADC Summary, ATmega ADC System and ADC Input Range Example
Lab		Stepping Motors (See Canvas Module – Week 10)
Assignment		Check Canvas!
Due		Check Canvas!

11	10/30-11/1	Digital electronics, basic logic functions
Learning obj.		11
Reading		IMD Chap 18 **Lecture Notes**: Digital Logic **Handouts:** (See Canvas Module): Logic Functions and Boolean Algebra, Combinatorial Logic Gate Examples, 7447 BCD to 7-segment Decoder Internals, Logic Levels-Logic Gate Construction
Lab		Electronic Scale (See Canvas Module – Week 11)
Assignment		Check Canvas!
Due		Check Canvas!
12	11/6-8	Logic gates, logic ICs
Learning obj.		11
Reading		IMD Chap 18 **Lecture Notes**: Digital Logic **Handouts:** (See Canvas Module): Logic Functions and Boolean Algebra, Combinatorial Logic Gate Examples, 7447 BCD to 7-segment Decoder Internals, Logic Levels-Logic Gate Construction, 555 Timer
Lab		Open Lab for term project, but Term Project Phase 2 Progress Review (NOTE: counts for 10% of your Term Project grade!!!!)
Assignment		Check Canvas!
Due		Check Canvas! **Term Project Phase 2 Progress Review** (show to your lab instructor during your lab section)
13	11/13-15	Sensors for mechatronic devices
Learning obj.		6
Reading		IMD Chap 13 **Lecture Notes**: TBD **Handouts:** (See Canvas Module): TBD
Lab		Open Lab for term project
Assignment		Check Canvas!
Due		Check Canvas!
14	11/20	Special topics in mechatronics
Learning obj.		TBD
Reading		TBD **Lecture Notes**: TBD Handouts (See Canvas Module): TBD
Lab		Open Lab for term project
Assignment		Check Canvas!
Due		Check Canvas!
15	11/27-29	Special topics in mechatronics
Learning obj.		TBD
Reading		TBD **Lecture Notes**: TBD Handouts (See Canvas Module): TBD
Lab		Open Lab for term project
Assignment		Check Canvas!
Due		Check Canvas!

16	12/4-6	12/4: **Term Project Exhibition** (beginning at 1630 and lasting until about 1930 in E125 and the hallways nearby) 12/6: Course review
Learning obj.		All
Reading		TBD **Lecture Notes**: TBD Handouts (See Canvas Module):
Lab		
Due		Check Canvas! Return any borrowed hardware.
17	12/11-14	12/11: **Term Project report and videos due by 11:59 pm.** Softcopy to Canvas **12/14: Final Exam: Friday December 14, 2018 from 1445 - 1700 in room WSQ 109.** (Bring a WiFi enabled laptop/notebook or iPad with Lockdown Browser installed)