ME 6405
INTRODUCTION TO MECHATRONICS

Modeling, the performance characteristics and application of microprocessors, analog and digital electronics to modern mechatronics systems and intelligent manufacturing – particularly smart sensors, controllers and actuators.

Instructor: Professor Charles Ume
Phone: 404-894-7411
Office: MARC Building, Room 453
Office Hours: Wednesday 4:00 pm to 5:00 pm, or by appointment
Class Meets: TTH 1:35 pm to 2:55 pm
Class Location: MRDC 2404
E-Mail: charles.ume@me.gatech.edu
Web Pages:
Course:  http://www.me.gatech.edu/mechatronics_course
Lab: http://www.me.gatech.edu/mechatronics_lab

Prerequisite:
ME 3015, System Dynamics and Control or Equivalent
ME 3056, Experimental Methodology Laboratory or Equivalent

Text:
1. Introduction to Mechatronics and Measurement Systems, Second Edition
   by David G. Alciatore and Michael B. Histand
2. Basic Microprocessors and the 6800, by Ron Bishop
4. MC68HC11E9 HCMOS Single-Chip Microcomputer (Motorola Semiconductor
   Technical Data)
5. Handouts
6. Every group of 3 students is required to purchase an Axiom CME11E9-EVBU
Reference Text


2. Design with Microprocessors for Mechanical Engineers by Stiffler

3. 6801, 68701, and Microcomputer Programming and Interface, by Andrew C. Stauggard

4. Design with Microcontrollers, by John B. Peatman

5. Understanding Electro-Mechanical Engineering, an Introduction to Mechatronics, by L. J. Kamm


8. Mechatronics: Mechanical System Interfacing, by D. M. Auslander


## Syllabus:

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
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</table>
| 4    | Basic Instrumentation  
8-Bit microprocessor: introduction, hardware overview, programming, interrupts, on-chip subsystems, parallel I/O |
| 2    | Choice of embedded computers (HC11 and PIC); choice of level of languages: low level (assembly), mid level (C), high level (basic and ladder logic). |
| 2    | Analog and digital devices: Op-amp, ADC, DAC, and power transistors |
| 2    | Modeling and control of electro-mechanical systems |
| 2    | Sensors, actuators, and their applications to intelligent manufacturing and mechatronic systems |
| 2    | {Modeling of various actuators: (DC motors, stepper motors, induction motors), and sensors (position, velocity, force, tactile, and ultrasonic)}  
OR {Programmable Logic Controller} |

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**Laboratory Exercises:**
There will be three electronics exercises and three labs during the semester. Electronics Exercises are done individually. Labs will be done in groups of three students.

- **Electronics Exercise #1**: Overview of Electronics Test Equipment, Soldering, and RC filters
- **Electronics Exercise #2**: 555 Timer and its Applications
- **Electronics Exercise #3**: Stepper Motor Controller & Driver
- **Lab #1**: Interfacing Communication with the MC68HC11 and sequencing Light Emitting Diodes
- **Lab #2**: Strain Gauge Data Acquisition Using A/D Conversion
- **Lab #3**: DC Motor Control Using Interrupts and Pulse Width Modulation (Open Loop Control)
- **Lab #4**: Programmable Logic Controller (PLC) Programming Assignment, if PLC lectures are given, (Bonus points will be given).

**Final (Group) Projects:**
1. This will be carried out in groups of three students.
2. Each group of students decides on what they will work on for their final project.
3. Projects are presented at the end of the semester.

This is a hands-on type of class!! Your final project may be eligible for invention disclosure!!
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**Grading:**

- 4 Quizzes (dates will be posted): 20%
- Test #1 (Oct. 6.): 20%
- **Lecture by Students (optional)**: 20%
- Test #2 (A week from last lecture): 20%

* If you choose to participate in the class lecture, you can apply the best two of your four grades above towards your final grade, otherwise the best two of the three will be used.

**Laboratory Exercises:**

- Electronic Exercise #s 1 & 2: 2 % each
- Electronic Exercise # 3: 3 %
- Lab # 1: 7 %
- Lab #s 2 & 3: 8 % each
- **Lab #4 (Optional)**: 2 % bonus

Laboratory Exercises Total: 30%

Group Final Project (Nov. 25): 30%
Notes:

1. This schedule is subject to change at the discretion of the instructor.

2. You are responsible for materials covered during your absence. There are no make-up lectures or quizzes. You will get zero for any test you missed, unless you made a prior arrangement with me and took it earlier.

3. Labs must be demonstrated to the TA, and lab reports submitted in the Lab the day they are due. Late Labs will be penalized 25% for every day they are late. Only labs 1 and 2 require lab reports.

4. You must always clean up before you leave the Lab.

5. Reviews of test grades must be done within one week after the test is returned.

6. Regular attendance is required in this class.

7. No make-up projects or assignments will be given for grade enhancement.

8. Every student must take all the two class tests and quizzes. You will loose 2% from your final grade for any test you missed and 1% for any quiz you missed.
**Laboratory Experience:**
You are required to complete the following:

1. Electronics Exercise 1: Overview of Electronics Test Equipment, Soldering, and RC Filters *(No Report)* (1 week)
2. Electronics Exercise 2: 555 Timer and its applications *(No Report)* (1 week)
3. Electronics Exercise 3: Stepper Motor Controller & Driver *(No Report)* (1 week)
4. Lab 1: Establish communication between the MC68HC11 and PC, and Sequencing light emitting diodes *(Report Required)* (2 weeks)
5. Lab 2: Strain gauge experiments *(Report Required)* (3 weeks)
6. Lab 3: DC Motor control experiment *(No Report)* (3 weeks)
7. Lab 4: Programmable Logic Control *(No Report)* (1 week)

**Lab Write-Up Procedure:**
1. Lab Objective (abstract)
2. Introduction
3. Experimental procedures or method (including drawings of the setup, circuitry and flow chart)
4. Discussion of the experimental results
5. Conclusion
6. References
7. Appendix
   - Program listings with good documentation
   - Specs for the components used in the circuitry
Lab Report Requirements:

1. Labs should be done exactly in accordance with procedures set out in the Course Outline, Lab Write-Up Procedure section.

2. Contents of the report should include answers to the questions proposed in the Understanding Objectives section of each Lab.

3. The report should by no means be strictly confined to the discussion of these questions.

4. The answers to the questions should be written in essay form and not delineated by question number; that is, the report should be a smooth and flowing document.

5. All lab demonstrations must be done in the Lab room on assigned days only.
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**Final Project:**
It is the responsibility each group to purchase the materials for their final project. You are encouraged not to spend more than $25.00 per student in your final project. Consider your final project as a low cost proof-of-concept, and not the final product.

1. This must be done in groups of three students. It is your responsibility to choose your partners.

2. Your group will meet as often as necessary to decide on the project that you would like to work on, and to work on it from its conception until it is finished.

3. Your grade in the project will be determined by your individual contribution and presentation, the creativity/novelty/quality of your project, your project web site and final report.

4. A one-page proposal of your final project is **due exactly four weeks** from the first day of classes.
Final Project (Continued):

5. There are sample final projects on the Mechatronics Lab web page:
   http://www.me.gatech.edu/mechatronics_lab

6. The final project presentation will be on Dec. 1
   - The presentation schedule will be made available about one week before the presentation date.
   - You are required to hand in your final report prior to your presentation.
   - Each group must develop a web page for their final project.
Grading Forms
### ME 6405: Introduction to Mechatronics Final Project Evaluation Worksheet

**Project Title:**

**HC11 Subsystems (Each Group Must Use at Least Four):**

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog to Digital Converter</td>
<td>Serial Peripheral Interface</td>
</tr>
<tr>
<td>Main Timer</td>
<td>On-Chip EEPROM</td>
</tr>
<tr>
<td>Pulse Accumulator</td>
<td>Off-Chip EEPROM</td>
</tr>
<tr>
<td>Parallel Input/Output</td>
<td>Maskable/Nonmaskable Interrupts</td>
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<tr>
<td>Serial Communication Interface</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group Member’s Name</th>
<th>Comments on his/her Efforts</th>
<th>% Individual Effort</th>
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<tbody>
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<td>4.</td>
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### Other Measures of Success:

<table>
<thead>
<tr>
<th>Category</th>
<th>Superb</th>
<th>Good</th>
<th>Average</th>
<th>Fair</th>
<th>Poor</th>
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<tbody>
<tr>
<td>Usefulness</td>
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<td>Uniqueness/Creativity</td>
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<td>Construction Quality</td>
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<td>Control Implementation</td>
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<tr>
<td>Aesthetics</td>
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<td>Demonstration</td>
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<td>Knowledge Gained</td>
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<td>Presentation</td>
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<tr>
<td>Project Report</td>
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<td>Website</td>
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Comments: __________________________________________

_________________________________________________________________

_________________________________________________________________

TOTAL SCORE (30): ___________  GRADER: ___________________________  DATE: ___________
# Group Lecture Evaluation Worksheet

Subject Presented: ____________________________________________

Presenter: ________________________________________________

<table>
<thead>
<tr>
<th>Basis for Evaluation</th>
<th>Grade of a 10-Point Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Knowledge of the subject matter</td>
<td>_________________________</td>
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<tr>
<td>2. Effectiveness of the presentation</td>
<td>_________________________</td>
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<tr>
<td>3. Time Management</td>
<td>_________________________</td>
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<tr>
<td>4. Effort put in and depth of presentation</td>
<td>_________________________</td>
</tr>
<tr>
<td>5. Handouts and Transparencies</td>
<td>_________________________</td>
</tr>
<tr>
<td>6. I would like him/her to lecture again</td>
<td>_________________________</td>
</tr>
</tbody>
</table>

**Average**

Note: 9 to 10 points = A; 7 to 8 points = B; 5 to 6 points = C; 0 to 4 points = F

**COMMENTS:** ____________________________________________