Syllabus

MEE 4177 Design & Realization of a Mechanical System (Mechatronic Design)

Fall, 2025

Department of Mechanical Engineering
Temple University

Course Credits: 3
Instructor: Dr. Osman Sayginer (sayginer@temple.edu)
Time and Location: M W F 9:00 am - 9:50am at Mazur Hall 002 // Changed to IDEAD Hub
Office Hours: M T W 1:00pm-2:00pm

Prerequisite:

MEE 1305	(C- or better, may be taken concurrently)
MEE 2305	(C- or better; may not be taken concurrently) AND
ENGR 3001	(D- or better, may not be taken concurrently) AND
ENGR-3571	(C- or better, may not be taken concurrently) AND
ENGR-3553/3953	(C- or better, may not be taken concurrently) AND
MEE 3301	(D- or better, may not be taken concurrently) AND
MEE 3117	(D- or better, may be taken concurrently)

Course Type: Required course in BSME program.

Reference Textbooks:

- Hehenberger, Peter, and David Bradley, eds. Mechatronic Futures. Springer International Publishing, 2016. https://doi.org/10.1007/978-3-319-32156-1.
- Rahman, Md. Mizanur, Farhan Mahbub, Rumana Tasnim, and Rezwan Us Saleheen, eds. Mechatronics: Fundamentals and Applications. Emerging Trends in Mechatronics. Springer Nature Singapore, 2024. https://doi.org/10.1007/978-981-97-7117-2.
- Pahl, Gerhard, Wolfgang Beitz, Jörg Feldhusen, and Karl-Heinrich Grote. Engineering Design. Springer, 2007. https://doi.org/10.1007/978-1-84628-319-2.

Online versions of the textbooks are available at Temple University Libraries.

<u>Specific goals for the course</u>

a. Course Learning Objectives.

At the end of this course student teams (**SO-5)** will:

i. Use foundational engineering science knowledge to design an integrated system that performs a prescribed function (SO-2a, 2b, 2c)
ii. Iterate the design to maximize performance, accuracy, and repeatability. (SO-2b)
iii. Select component materials for the design which demonstrably minimize the carbon footprint of the design and its operation (SO 2a)
iv. Fabricate the components of the design as needed (SO-2d)
v. Assemble and test the functional prototype, and use data acquisition to quantify design performance (SO-2b, 2d, SO-6c, RCT.2)

b. **Student outcomes and performance indicators**

i. **SO-2 "**An ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors."
   - **(2.a)** Identifies the need for the engineered solution; gathers relevant information for the development of the design; and identifies all stakeholders for the execution of the design, including considerations of public health and welfare, and evaluating cultural, social, an environmental consequence.
   - **(2.b)** Enumerates limits imposed on the design; identifies risks entailed in the design's development and implementation; develops design specifications, quantified where possible, using technical/professional engineering codes as appropriate.
   - **(2.c)** Ideates multiple candidate solutions; systematically evaluates engineered design options corresponding to these multiple candidate solutions w.r.t. design specifications and constraints.
   - **(2.d)** Validates the design, where appropriate, by creating a physical prototype, and/or verifying the engineered solution through analysis, computer simulation, and a suitable testing regimen of the prototype.

ii. **SO-5** "An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives."

iii. **SO-6** "An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions."
   - **(6.c)** Devises and carries out experimental procedures for quantifying either (i) a process, or (ii) the performance of an engineered device.

iv. Required curricular topics (program-specific accreditation criteria) are:
   - **(RCT.2) that** student's model, analyze, design, and realize physical systems.

Course Description and Design Concept Overview – Fall 2025

This project-based course challenges student teams to design, fabricate, and test a mechatronic system capable of performing a real-world waste management task. All teams will address a common design problem, inspired by the ASME Student Design Competition AY25–26: Waste Collection Challenge.

The objective is to develop a compact, efficient device that can extract small waste items from stationary bins without causing any damage or shifting the bins' positions. Once extracted, the device must identify and sort the waste items based on color or shape into two distinct categories. For instance, green or blue may represent recycling, and black or red may indicate garbage.

Each collection bin will measure between 3.81 × 3.81 × 6.35 cm and 5.08 × 5.08 × 7.62 cm, containing small cube-shaped waste units ranging in size from 1.27 cm to 2.54 cm. The entire system, including all components, must fit within a 50 × 50 × 50 cm rigid sizing box, which must remain closed during transportation and storage throughout the competition.

The device will be manually positioned near bins at the start of each trial. Once activated, it must autonomously or remotely execute all retrieval, classification, sorting, and dumping operations.

The system must integrate the following core mechatronic subsystems:

- A microcontroller-based control unit for managing motion and decision logic
- Sensors for color detection and object recognition
- Actuated mechanisms for waste extraction from bins
- Internal sorting components to separate and store different waste categories

Emphasis will be placed on system reliability, precision, and adherence to the official rules and safety standards of the ASME Student Design Competition. A significant portion of the course grade will be based on the quality of design, build execution, and performance during demonstrations.

Further details on the ASME Student Design Competition can be found at:
https://efests.asme.org/competitions/student-design-competition-(sdc)

COURSE PLAN – FALL 2025

	Starting Dates of the week	08/25	09/01	09/08	09/15	09/22	09/29	10/06	10/13	10/20	10/27	11/03	11/10	11/17	11/24	12/01
	Weeks ▶	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Introduction	**Problem Definition & Grouping** •Definition of the Mechatronics Design Problem	MWF	MWF													
Introduction	**Brainstorm** •Potential solution proposals from groups [Proposal Presentation]		MWF													
Introduction	**Theory and Mechatronics Design Concepts** •System Modelling, Feedback Control, Micro Controllers, Motors, Sensors, Computer Vision [Proposal Paper][Quiz #1]			MWF	MWF											
Mechatronics System Development	**Trash Collection System** •Development of a system capable of detecting and collecting all waste objects from within a trash bin. •Potentially a tubular conveyor system with wheels or a spiral mover. [Progress Presentation #1] **[1st Match]**[Quiz #2]					MWF	MWF	MWF	MWF							
Mechatronics System Development	**Waste Sorting System** •Computer Vision System to separate waste into two groups. •Potentially a camera-based color detection or color sensitive sensors. [Progress Presentation #2] **[2nd Match]** [Quiz #3]								MWF	MWF	MWF	MWF				
Experimentation & Performance Evaluation	**Full System Performance Evaluation** •Students will test the full functionality of their systems. [Individual Application Exam] **[3rd Match]** [Final Report]											MWF	MWF	MWF		MWF

Marker	M	W	F	X	X	X	X	X
Meaning	Monday	Wednesday	Friday	No Class	Exam	Group Event	Match	Quiz

*The course plan may undergo minor changes depending on the course progress.
** The course plan includes colored content. Black-and-white printouts may cause misunderstandings

Grade Distribution

Task	%	Remarks
Proposal	10	**Presentation** • Should include a clearly defined design concept and a feasible roadmap to address the design problem. • Must demonstrate an understanding of the mechanical, electronic, and informatics (software) components of the design. • Should outline task distribution among team members.
	10	**Paper** • Should include concept design, incorporating feedback received after the presentation. • Must include a detailed engineering design: A complete bill of materials (BoM), Clearly described manufacturing methods, A Gantt chart showing project timeline and milestones, Scientific references to support design decisions and methodology. • Must follow the provided report template. • Must incorporate appropriate mathematical notation and formulations relevant to the design and analysis.
Quiz	5	• Quizzes will be based on reading assignments. • In total 3 quizzes will be given. • The lowest quiz score will be dropped.
Application Exam *(Individual)*	20	• The exam may include practical questions derived from the application components of the group projects • Topics may include Algorithm development, Circuit design and implementation, Embedded systems coding, post-experiment data analysis
Progress Presentation	20	• Present the overall design concept and current development status. • Outline completed and upcoming prototyping milestones. • Show progress in mechanical, electrical, and software subsystems. • Provide evidence of testing and validation of components. • Update the bill of materials (BoM) if relevant. • Summarize team member contributions and task assignments. • Highlight current challenges and proposed solutions. • Support with visuals (e.g., CAD, circuit diagrams, test data).
Matches	10	**Team Competition** • Each team will participate in a total of three matches. • The lowest-scoring match will be dropped from the final evaluation. • Scoring Criteria per Match: • Win: 100% Tie: 50% Loss: 0% No Game: 0%
Final Report	25	• A comprehensive final report must be submitted in manuscript format. • The report should include a complete overview of the prototype's mechanical, electrical, and software components. • The performance of the device must be presented with statistical analysis, demonstrating reliability, repeatability, and effectiveness under different test conditions.
Attendance	NA	• Random attendance checks will be conducted during lecture hours. • Failure to check in, even if physically present, will not be excused. • Misuse of the attendance system (e.g., checking in on behalf of another student) will result in a failing grade (F) for the course. • More than two unexcused absences will result in a failing grade (F) for the course.

Grading Scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
100% to 94%	< 94% to 90%	< 90% to 87%	< 87% to 84%	< 84% to 80%	< 80% to 77%	< 77% to 74%	< 74% to 70%	< 70% to 67%	< 67% to 64%	< 64% to 61%	< 61% to 0%

Disability disclosure: Any student who has a need for accommodations based on the impact of a documented disability or medical condition should contact Disability Resources and Services (DRS) in 100 Ritter Annex (drs@temple.edu; 215-204-1280) to request accommodations and learn more about the resources available to you. If you have a DRS accommodation letter to share with me, or you would like to discuss your accommodations, please contact me as soon as practical. I will work with you and with DRS to coordinate
reasonable accommodations for all students with documented disabilities. All discussions related to your accommodations will be confidential.

Student and Faculty Academic Rights and Responsibilities Policy (#03.70.02): Freedom to teach and freedom to learn are inseparable facets of academic freedom. The University has a policy on Student and Faculty Academic Rights and Responsibilities (Policy #03.70.02) which can be accessed at policies.temple.edu.

Student Electronic Information (E-Mail) Policy: Temple University Policy Number 04.74.11, dated December 10, 2002, sets forth the guidelines and requirements regarding the use of e-mail as an official means of communication throughout Temple University. This policy also requires that all Temple students obtain an @temple.edu e-mail address upon their entrance into the University. The instructor's means of communication with students outside of the classroom will be via e-mail. As such, if you do not currently have an @temple.edu address, you should immediately obtain one as required by Policy Number 04.74.11. The complete text of this policy as well as all Temple University policies can be found at http://policies.temple.edu.