ENME473 / ENME690
Mechanical Fundamentals of Electronic Systems
Fall 2021

MW 2:00 – 3:15 PM **2121 J. M. Patterson Hall (JMP)**

Instructor:
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Teaching Assistant:
TBD

Office Hours:
Dasgupta: Monday and Wednesday 4:00--5:00 PM (or by appointment)
TA: TBD (or by appointment)

Philosophy of the Course:
Advanced packaging and heterogeneous integration has permitted the integration of electronics into all manner of products and applications, embedding electronics into every facet of our lives. It has facilitated the mobile computing revolution, and been instrumental in creating wearable electronics, implantable health monitors, and energy efficient vehicles. The design of electronic systems requires engineering expertise from many different disciplines. In fact, cost, size, weight, manufacturability, quality, reliability, and even commercial success of electronic systems are often more a function of mechanical design than electrical design. The objective of the course is to introduce seniors and first year graduate students to the principles of mechanical engineering required for designing and manufacturing reliable electronic systems and to lay the groundwork for further study in this area. Students will master the necessary background science and mathematics to become proficient designers of electronic hardware. Furthermore, interpersonal, teamwork, and communication skills will be developed through practical deconstruction and design projects. Course topics will include fundamental principles of active and passive electronic devices; MEMS and microsystems; design of components, circuit boards, connectors, and assemblies; additive and subtractive manufacturing techniques; and vibration, shock, fatigue, and thermal analysis of assemblies. The course will culminate in the deconstruction analysis of actual electronic systems and the design of improved packaging.

Attendance: Sitting in or auditing the class will not be permitted without the consent of the instructor. Attendance will be taken periodically.

Website: Course notes, homework assignments, homework and exam answers, discussion questions, and grades will be posted on CANVAS and/or on Gradescope, as appropriate. Please submit all homework and other assignments via Gradescope.

MID-TERM EXAM: Mon, Oct 04, 2:00-3:15 PM in JMP 2121

FINAL EXAM: Sat, Dec 18, 1:30-3:30 PM in JMP 2121 (FIXED DATE)

Course Outline (subject to change):

Lecture #	LECTURE TOPICS
08/30	Introduction to Electronic Packaging
09/01	Semiconductor Devices and Processing
09/06	Multilevel chip metallization and Semiconductor Failure Mechanisms
09/08	Basics of Packaging – Packaging Taxonomy (Classification)
09/13	Wirebonding (Al, Au, Cu, Multilayer)
09/15	Flip Chip and Alternate Interconnection
09/20	Die Attach and Leadframe
09/22	Plastic Encapsulation
09/27	Area Array Packaging and Chip Scale Packaging
09/29	Organic and Ceramic Substrates
10/04	**MID-TERM EXAM**
10/06	Electrical Design of Printed Wiring Boards
10/11	Electrical Design of Printed Wiring Boards
10/13	Mechanical Design of Printed Wiring Boards
10/18	Manufacture of Printed Wiring Boards and PWB Failure Mechanisms
10/20	Lead-free Soldering; Soldering Processes and Defects
10/25	Thermal Analysis
10/27	Thermal Analysis
11/01	Thermal Management
11/03	Vibration Analysis
11/08	Vibration Analysis
11/10	Drop and Impact Analysis
11/15	Physics of Failure Reliability Assessment & Accelerated Testing
11/17	Physics of Failure Reliability Assessment and Prognostics
11/22	Power Electronics and Extreme Temperature Electronics
11/24	**THANKSGIVING BREAK**
11/29	Separable Connectors
12/01	Special Topics: Heterogeneous Integration (2.5D/3D, WLFI/FO, SOC/SOP/SIP)
12/06	Special Topics in Electronics Packaging (MEMS, Sensors, Flexible/Wearable Electronics)
12/08	Special Topics in Electronics Manufacturing (Additive Manufacturing - Printed Electronics)
12/13	Summary and Review

Class Project: Reverse Engineering of Electronic Packaging

- Students will be grouped into teams of (typically) 4 students (2 graduate and 2 undergraduate students).
- Each team will deconstruct a common portable electronic product and examine its packaging.
- Each team must supply their own device such as the following: Tablet, MP4 Device, game controller, health monitoring device, electronic watch, handheld GPS, TV remote control, etc.
- The teams will be responsible for using what they learned in class to redesign the product and some aspect of its thermal or mechanical design, so it is lighter, smaller, cheaper, and more reliable than the original with improved performance.
- Final reports will consist of a deconstruction video with an explanation of each of the elements of the packaging and suggestions for redesign; together with a written report that includes a summary of the packaging along with details of the redesign.
- Teams/devices for projects will be finalized by **Mon, Sep 20, 2021.**
- Final reports and videos are due via Gradescope on **Wed, Dec 8, 2021.**

Graduate Project: Reliability Assessment of Electronic Modules

- Students will be grouped into teams of (typically) 5 graduate students.
- Each team will study a commercially available electronic module (e.g. Power supply, Sensor Module, LED lamp, etc.) identify key elements of construction and measure critical parameters.
- Each team will identify and use failure mechanism models together with accelerated test data; field data; design measurements; analysis (thermal or mechanical or moisture absorption); and the mission profile; to assess the reliability of the module.
- Teams are then responsible for using what they learned in class to redesign the product so it is lighter, smaller, cheaper, and more reliable than the original.
- Final reports in written form are due via Gradescope on **Wed, Dec 15, 2021.**

Grading Policy

Graduate Grading: Out of 120%

- Mid-term Exam: 30%
- Final exam: 35%
- Class Project 25%
- Quizzes and Homework: 10%
- Graduate Project: 20%

Undergraduate Grading: Out of100%

Mid-term Exam: 30%
Final exam: 35%
Class Project: 25%
Quizzes and Homework: 10%

Course Related Policies:

Please note that this course will be conducted in accordance with UMD's course policies, available at this link: http://www.ugst.umd.edu/courserelatedpolicies.html. These policies address important updates regarding:

- Academic Integrity and Plagiarism (also see: https://president.umd.edu/sites/president.umd.edu/files/documents/policies/III-100A.pdf)
- Accessibility & Disability Services (formerly Disability Support Services)
- Civil Rights & Sexual Misconduct (OCRSM)
- CourseEvalUM
- Excused Absence Policy

Please review this link carefully as you are responsible for adhering to these policies.