

## UMBC UGC New Course Request: ENME 472 The Materials and Processes for micro/nanoscale systems (MEMS)

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Proposed Effective Date: Fall 2010

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### COURSE INFORMATION:

Course Number(s)	ENME 472
Formal Title	The Materials and Processes for micro/nanoscale systems (MEMS)
Transcript Title (≤24c)	Materials for MEMS
Recommended Course Preparation	
Prerequisite	ENME 301, ENME 220
Credits	3
Repeatable?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
Max. Total Credits	3
If yes, how many total credits?	
Grading Method(s)	<input checked="" type="checkbox"/> Reg (A-F) <input type="checkbox"/> Audit <input type="checkbox"/> Pass-Fail

### PROPOSED CATALOG DESCRIPTION:

A fundamental course presenting key topics in materials and processing for the design and manufacture of micro and nano scale systems often called microelectromechanical systems (MEMS). Students will focus on understanding materials and microfabrication technologies commonly employed in these small scale systems. Material properties, parameters and their relationship with microfabrication processes, length scale and applications are discussed with regards to elastic and inelastic deformation, fracture, residual stress, fatigue, creep, adhesion, and stiction. Case studies on devices for sensing and actuation applications will be addressed to connect the course topics.

### RATIONALE FOR NEW COURSE:

a) Why is there a need for this course at this time?

This course captures an emerging field of study that currently is not addressed in the Mechanical Engineering curriculum at the undergraduate level. This course already has an advance graduate component.

b) How often is the course likely to be taught?

Once per academic year

c) How does this course fit into your department's curriculum?

It will act as a technical elective with a design component.

d) What primary student population will the course serve?

Upper level mechanical engineering students, but the topic is multidisciplinary and it is expected to draw from other departments including but not limited to Physics, electrical engineering, and chemical engineering.

- e) Why is the course offered at the level (ie. 100, 200, 300, or 400 level) chosen?
- f) Explain the appropriateness of the recommended course preparation(s) and prerequisite(s).

The course builds off the student's fundamental understanding of particular mechanics and materials concepts that are covered in the listed prerequisites.

- g) Explain the reasoning behind the P/F or regular grading method.
- h) Provide a justification for the repeatability of the course.

**ATTACH COURSE OUTLINE (mandatory):**

# The Materials and Processes for micro/nanoscale systems (MEMS)

# UMBC

AN HONORS UNIVERSITY IN MARYLAND  
Spring 20XX



## ACADEMIC INTEGRITY

“By enrolling in this course, each student assumes the responsibilities of an active participant in UMBC’s scholarly community in which everyone’s academic work and behavior are held to the highest standards of honesty. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty, and are wrong. Academic misconduct could result in disciplinary action that may include, but is not limited to, suspension or dismissal. To read the full Student Academic Conduct Policy, consult the UMBC Student Handbook, the Faculty Handbook, or the UMBC policies section of the UMBC Directory.” *UMBC Faculty Senate, February*

**Lectures: TBA**

## **Administrative Information**

Instructor: Dr. Marc Zupan (mzupan@umbc.edu)  
Office E 225-L  
Office Hours: TBA

Teaching Assistant: TBA

Primary TEXT: S. Franssila, *Introduction to Microfabrication: Wiley and Sons, Ltd (2004)*  
*ISBN: 0-470-85105-8*

Auxiliary TEXT: S.D. Senturia, *Microsystems Design*  
N. Maluf, *An Introduction to Microelectromechanical Engineering*  
Tai-Ran Hsu, *MEMS and Microsystems Design and Manufacture*

## **Grading:**

Midterm	(20%)
Quizzes (5 total drop lowest)	(20%)
Homework (labs, projects, etc)	(35%)
Final Exam- <i>Comprehensive</i>	(25%)

## **Grade Break Down:**

100-90%	A
89-80%	B
79-70%	C
69-60%	D
59->	F

~Please note: I **DO NOT** accept late assignments. Assignments are turned in at the **START** of class on the date it is due. I take this **VERY SERIOUSLY** and you will be **disappointed** if you try to turn in late assignment.

~Homework will be assigned and is due at the start of lecture one week after it is assigned

***Make up assignments: I strictly adhere to the policy of the UMBC senate listed below.***

(Adopted by UMBC Faculty Senate October, 1991)

Make-up examinations shall be provided without penalty when the student's absence is the result of religious observance, illness, death in the immediate family, participation in official University activities at the request of appropriate faculty or staff, or other compelling circumstances beyond the student's control. In the case of illness or death in the immediate family, the instructor may require the student to provide documentation from a personal health care provider, Student Health Services or other official source. With respect to participation in scheduled, authorized University activities, the instructor's obligation to give a make-up examination is conditional on prior notice of the absence on official departmental stationery by the appropriate faculty or administrator. The student is responsible for seeing that the notice reaches the instructor in a timely fashion. With other requests, the instructor has the option of determining whether compelling circumstances exist. In cases of dispute, the student may appeal to the Chair of the Department offering the course. Appeals must be made within one week of refusal of the request to take a make-up examination.

### **Course Description**

	<b>Topic</b>
1	Overview of Microelectromechanical Systems
2	Materials Selection and scaling in MEMS using material indices
3	Materials- Crystallography of MEMS materials focus on Silicon
4	Surface Micromachining- Lithography, film etching, deposition, oxidation
5	Bulk Micromachining- anisotropic wet etching, LIGA, deep reactive ion etching
6	Characterization of MEMS materials and structures
7	Mechanics Design- Beam and membrane Theory in MEMS
8	Properties of thin films and structures- Elasticity and Plasticity
9	Properties of thin films and structures- Fatigue and Fracture
10	Mechanics- Material requirements for designing beam and membrane systems
11	Fluid Mechanics- Basic theory in Continuum- Incompressible Fluid Flow in Microconduits
13	Microfluidics- Submicrometer and Nanoscale Fluid flow
14	Materials Selection for MEMS device design- Case Studies
15	Design Case Study- Fabrication (Microaperture, Micropumps)
16	Emerging MEMS Topics - Polymers for MEMS, BioMEMS
17	Emerging MEMS Topics - Shape memory alloys, Piezoelectric

A fundamental course presenting key topics in materials and processing for the design and manufacture of microelectromechanical systems (MEMS). Students will focus on understanding materials and microfabrication technologies commonly employed in MEMS. Material properties, parameters and their relationship with microfabrication processes and applications are discussed with regards to elastic and inelastic deformation, fracture, residual stress, fatigue, creep, adhesion, and stiction. Case studies on devices for sensing and actuation applications will be addressed to connect the course topics.

***Outcomes***

There are a number of objectives that we wish to pursue through the activities of this course. Your performance will be evaluated throughout the course in light of these objectives and the corresponding outcome. In this course, we will expect the student to:

<b>Course Objectives:</b>	<b>E</b>	<b>V</b>	<b>G</b>	<b>F</b>	<b>P</b>
To introduce the students to the multidisciplinary scientific concepts of Miroelectromechanical (MEMS) devices.					
Students learned to draw upon a variety of previous engineering courses.					
Students developed basic skills to foster the design, fabrication, and validation of MEMS devices.					
Students produced written homework to display their command of the course material.					
Students develop modeling techniques as well as using numerical MEMS device simulators to do virtual designs of devices.					
Students used and learned Engineering fundamentals including data analysis, properties of materials, mechanics, fluid dynamics, computer analysis to solve problems.					
Students learned to analyze MEMS structures.					
Students learned the basic concepts of MEMS Production and Design					
The student have had opportunities to further his/her professional development through external seminars and in class invited speakers					