UNDERGRADUATE STUDENT MANUAL

Department of Mechanical Engineering and Applied Mechanics

University of Pennsylvania

August 2014

www.me.upenn.edu

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WHAT IS MECHANICAL ENGINEERING AND APPLIED MECHANICS?

Studying Mechanical Engineering and Applied Mechanics teaches you how to analyze, design, and manufacture components, machines, and systems that can withstand force, deformation, heat, and motion while accomplishing a wide variety of useful functions for humanity.

The Department

The Department of Mechanical Engineering and Applied Mechanics (MEAM) was the second engineering curriculum established at the University of Pennsylvania (circa 1872). Our many alumni are noted for their distinguished careers and contributions in engineering, management, science, and education.

Careers in Mechanical Engineering and Applied Mechanics

The MEAM curriculum at Penn offers students a broad-based education that will allow them to adapt to developments in technology in a rapidly changing society. At the same time, the curriculum offers the flexibility to specialize in one or more areas in mechanical engineering such as energy engineering, mechanical design, fluid mechanics, or structural mechanics, as well as cross-disciplinary areas as robotics, biomechanics, micro-electromechanical systems (MEMS), and mechanics of materials. Our students are encouraged to do research during their course of study and are provided every opportunity to master critical skills that will enable success in their future careers.

The career opportunities available to our graduates are perhaps the broadest among all fields of engineering. A wide variety of industries recruit mechanical engineers, including aerospace, automotive, electronics and computers, chemical, and biomedical. Positions range from research and development to design and manufacturing to field engineering and marketing. Some recent graduates have taken positions with consulting and financial institutions, while others have gone on to graduate studies in engineering, business, law, and medicine.

ADVISING AND DEGREE INFORMATION

Undergraduate Advisor

Each MEAM student is assigned a faculty advisor. This faculty member will work with the student to select courses and will need to approve administrative actions such as course enrollment and petitions. He or she will also serve as a resource for advice on academic, career, and other issues that may arise. Every effort will be made to maintain continuity year-to-year, but there are circumstances where advisors may need to be changed. Similarly, students are always free to change to any advisor that will accept them. Students must consult with their advisor at least once each semester. Students in academic difficulties should meet with their advisor as soon as possible to obtain guidance.

Mail Folders

Every student in the School of Engineering and Applied Science has a personal mail folder, which is used for distributing announcements and returning graded assignments. Undergraduate mail folders for the MEAM Department are located on the second floor of the Towne Building in room 279. Students should get into the habit of checking their mail folder on a regular basis.

Submatriculation

Undergraduate students may begin an engineering graduate program while still completing their undergraduate program. Application is normally made before the end of the student's junior year. The submatriculant may take up to three graduate courses to fulfill both undergraduate and graduate degree requirements while registered as an undergraduate student. To apply for submatriculation, submit an application via Penn's online application system. A minimum GPA of 3.0 is required in order to apply.

Minor in Mechanical Engineering and Applied Mechanics

Non-major students can earn a minor in Mechanical Engineering and Applied Mechanics (MEAM) by completing at least six approved course units with a grade of C or better. Courses taken on a pass/fail basis do not count toward the MEAM minor. The approved courses include all courses with the prefix MEAM and ENM 427, except MEAM 445 and 446 (Senior Design). At most two course units may be at the 100 level (i.e., MEAM 1XX). Up to two cognate courses can be substituted for MEAM courses. Please see the departmental website for an up-to-date listing of cognate courses:
http://www.me.upenn.edu/prospective-students/undergraduates/majors-minors.php#minor

STUDENT ORGANIZATIONS

Student engineering societies are a strong force in shaping professional attitudes and providing information about the profession and job directions. Student organizations also provide opportunities for meeting practicing engineers and for socializing with people of similar professional interests.

The School of Engineering and Applied Science maintains an online list of active student organizations: http://www.seas.upenn.edu/undergraduate/student-life/index.php

At the time of printing, the listed groups included the Engineering Student Activities Council (ESAC), the Engineering Dean's Advisory Board (EDAB), American Institute of Chemical Engineers (AIChE), American Society of Mechanical Engineers (ASME), Biomedical Engineering Society (BMES), CommuniTech, Computer Science Dining Philosophers (CSDP), Engineering Pre-med Club (eMED), Eta Kappa Nu (EKN), Formula SAE Racing, Hexagon, Institute of Electrical and Electronics Engineers (IEEE), Materials Science and Engineering Society, Management and Technology Club (M&T Club), National Society of Black Engineers (NSBE), Penn ACM SIGGRAPH, Penn Electric Racing, Penn Engineers Without Borders, Society of Hispanic Professional Engineers (SHPE), Society of Systems Engineers (SSE), The Society of Hispanic Engineers (SHPE), Society of Women Engineers (SWE), Tau Beta Pi (TBP), Technology Entrepreneurship Club (TEC), Theta Tau, and Women in Computer Science (WICS).

Below are brief descriptions of the student organizations that are most closely related to MEAM.

ASME Student Chapter
www.seas.upenn.edu/~asme/
Penn's American Society of Mechanical Engineers (ASME) chapter is a student-run technical and professional society. Students elect their own officers and coordinate a variety of academic, professional, and social activities.
President: Sean Reidy, reidys@seas.upenn.edu
Faculty Advisor: Prof. Katherine J. Kuchenbecker, kuchenbe@seas.upenn.edu

Formula SAE: Red and Blue Racing
www.seas.upenn.edu/~fsae/
Students design, fabricate, and compete nationally with a formula-style race car. The vehicles are judged in three different categories: static inspection and engineering design, solo performance trials, and high-performance track endurance. *See note below under PER.*
Captain: Matt Piccoli, piccoli@seas.upenn.edu
Faculty Advisor: Prof. Andrew Jackson, andjac@seas.upenn.edu

National Society of Black Engineers
www.dolphin.upenn.edu/nsbe/
The mission of NSBE is to increase the number of culturally responsible Black Engineers who excel academically, succeed professionally and positively impact the community.
President: Camille Davis, camdavis@seas.upenn.edu
Advisor: Cora Ingrum, ingrum@seas.upenn.edu

Penn Electric Racing

www.seas.upenn.edu/~electric/

Penn Electric Racing has roots in the American Solar Car Challenge and now focuses on battery-powered vehicles. The club's purpose is to build efficient electric vehicles, promoting the idea that clean energy and high performance are not mutually exclusive. Students take vehicle projects from conception to the pavement, with opportunities in design, simulation, fabrication, testing, and organized competition. *For 2014-15, PER will work with FSAE in an all-out effort to enter a high-performance electric vehicle in an upcoming international competition.*

Captain: Adam Farabaugh, adamfara@seas.upenn.edu

Faculty Advisor: Prof. Andrew Jackson, andjac@seas.upenn.edu

The Society of Hispanic Professional Engineers

www.seas.upenn.edu/~shpe/

SHPE promotes the development of Hispanics in engineering, science and other technical professions to achieve educational excellence, economic opportunity and social equity.

Email: shpe@seas.upenn.edu

Advisor: Prof. Paulo Arratia, parratia@seas.upenn.edu

The Society of Women Engineers

fling.seas.upenn.edu/~swe/cgi-bin/

The mission of SWE is to stimulate women to achieve full potential in careers as engineers and leaders, to expand the image of the engineering profession as a positive force in improving the quality of life and to demonstrate the value of diversity.

Email: pennswe@gmail.com

Advisor: Prof. Danielle Bassett, dsb@seas.upenn.edu

CURRICULUM IN MECHANICAL ENGINEERING AND APPLIED MECHANICS

Mechanical engineering students are expected to formulate a degree program that is well grounded in the fundamentals of mechanical engineering while having the breadth that is necessary in today's technology-intensive workplace. The curriculum allows the student to pursue a number of elective options in depth, either in traditional mechanical engineering subjects or in one or more multidisciplinary engineering programs at Penn. Flexibility in the curriculum, primarily in the junior and senior years, enables the student to study fields such as aeronautics, robotics, design and manufacturing, mechatronics, business administration, advanced mathematics, control systems, and mechanics of materials.

To earn a BSE in MEAM, a student must complete at least 40 course units distributed among six categories, as listed below:

5 credit units	= Math
5 credit units	= Natural Science
10 credit units	= Core MEAM courses
10 credit units	= Professional Electives
7 credit units	= General Electives
+ 3 credit units	= Free Electives
40 credit units	= Total

MEAM students must follow all of the rules and regulations described in the **Penn Engineering Undergraduate Student Handbook**: http://www.seas.upenn.edu/undergraduate/handbook/index.php

COURSE PLANNING GUIDE

The following page contains the Course Planning Guide (CPG), which indicates which courses are required and which are recommended in each of the above categories. The CPG also includes websites that provide further information on important topics such as the writing requirement.

The CPG can also be found:

- MEAM website: www.me.upenn.edu/current-students/undergraduates/degree-requirements.php
- Penn InTouch: https://medley.isc-seo.upenn.edu/penn_portal/intouch/splash.html

MEAM COURSE PLANNING GUIDE

Math (5 CU)

www.seas.upenn.edu/undergraduate/handbook/courses/**math-courses**.php

❒ **MATH 104 Calculus I** (Section 7 is recommended)

❒ **MATH 114 Calculus II**

❒ **MATH 240 Calculus III**

❒ **ENM 251 or MATH 241 Calculus IV**

❒ ____________ [1]

1. Recom: EAS 205 Applications of Scientific Comp

Natural Science (5 CU)

www.seas.upenn.edu/undergraduate/handbook/courses/**nat-science-courses**.php

❒ **MEAM 110 Intro to Mechanics** [2]

❒ **MEAM 147 Intro to Mechanics Lab** [2]

❒ **PHYS 151 Principles of Physics II**

❒ **CHEM 101 Chemistry I** (Section 4, 5 or CHEM 091)

❒ **CHEM 053 Chemistry Lab I**

❒ __________ [3]

2. PHYS 150 is also acceptable.
3. Recom: BIOL 101 Intro. To Biology
   BIOL 121 Intro Bio-Molec Bio Life
   PHYS 280 Biological Physics

Core MEAM (10 CU)

❒ **MEAM 203 Thermodynamics I**

❒ **MEAM 210 Statics & Strength of Materials**

❒ **MEAM 211 Eng. Mechanics: Dynamics**

❒ **MEAM 247 ME Lab I**

❒ **MEAM 248 ME Lab I**

❒ **MEAM 302 Fluid Mechanics**

❒ **MEAM 321 Vibrations of Mechanical Sys.**

❒ **MEAM 333 Heat & Mass Transfer**

❒ **MEAM 347 ME Design Lab**

❒ **MEAM 348 ME Design Lab**

❒ **MEAM 354 Mechanics of Solids**

Note:
Bold courses are required MEAM courses.

Professional Electives (10 CU) [4]

❒ **MEAM 445 Design Project I**

❒ **MEAM 446 Design Project II**

❒ ENGR 105 Intro to Scientific Computing [5]

❒ MEAM Upper level______________ [6]

❒ MEAM Upper level_____________ [6]

❒ MEAM Upper level_____________ [6]

❒ Professional Elective____________ [7]

❒ Professional Elective____________ [7]

❒ Professional Elective____________ [7, 8]

❒ Professional Elective ____________ [7, 8]

4. Maximum of three 100-level courses.
5. CIS 110, CIS 120, or ESE 112 are also acceptable.
6. MEAM 404, 405, 410, 454, 455, all MEAM 500-level courses. MEAM 599 cannot count as upper level.
7. Math, Natural Science, or Engineering categories.
8. Advanced dual-degree requirements with approval.

General Electives (7 CU) [9, 10]

www.seas.upenn.edu/undergraduate/handbook/courses/**ssh-breadth**.php

www.seas.upenn.edu/undergraduate/handbook/courses/**tech-bus-courses**.php

❒ **EAS 203 Eng. Ethics** ❒ H ___________

❒ SS ___________ ❒ H ____________

❒ SS or H ___________ ❒ SS, H or TBS ________

❒ SS, H or TBS ____________

9. Two of these electives must be taken in the same department to fulfill the **Depth Requirement**:
www.seas.upenn.edu/undergraduate/handbook/courses/**ssh-depth**.php

10. One of these electives must fulfill the **Writing Requirement**:
www.seas.upenn.edu/undergraduate/handbook/courses/**writing-requirement**.php

Free Electives (3 CU)

www.seas.upenn.edu/undergraduate/handbook/courses/**free-elective**.php

❒ ________________________

❒ ________________________

❒ ________________________

MEAM B.S.E. SAMPLE FOUR-YEAR COURSE PLAN

Many courses have prerequisites, and therefore the sequence in which courses are taken may be important. The following sample course plan shows one sequence that satisfies the prerequisites for the specified courses. However, given the range of individual situations, each student must develop a complete course plan in consultation with his or her academic advisor.

Freshman Year

CUs	FALL	
1.5	**MEAM 110/147**	Intro to Mechanics & Lab
1	**MATH 104-007**	Calculus I
1.5	**CHEM 101/053**	Intro to Chemistry & Lab
1	Elective: Social Science/Humanities	
Note:	**Students with AP credit for MEAM 110 may take ENGR 105 and/or MEAM 101. Students with AP credit for MATH 104 should take MATH 114.**	

CUs	SPRING	
1.5	**PHYS 151**	Principles of Physics II & Lab
1	**MATH 114-002**	Calculus II
1	Professional elective (e.g., ENGR 105 or MEAM 101)	
1	Writing Requirement	
1	Natural Science elective	

Sophomore Year

CUs	FALL	
1	**MEAM 210**	Statics & Strength of Mat'ls
0.5	**MEAM 247**	MEAM Laboratory I
1	**MATH 240**	Calculus III
1	**EAS 203**	Engineering Ethics
1	ENGR 105 or another programming course	
1	Professional elective	

CUs	SPRING	
1	**MEAM 203**	Thermodynamics I
1	**MEAM 211**	Engineering Mechanics: Dynamics
0.5	**MEAM 248**	MEAM Laboratory I
1	**ENM 251 or MATH 241**	Analytical Methods for Eng. or Calculus IV
1	Social Science/Humanities elective	

Junior Year

CUs	FALL	
1	**MEAM 302**	Fluid Mechanics
1	**MEAM 354**	Mechanics of Solids
1	**MEAM 347**	Mechanical Engineering Design Lab
1	Social Science/Humanities elective	
1	Free elective	

CUs	SPRING	
1	**MEAM 321**	Vibrations of Mech. Systems
1	**MEAM 333**	Heat & Mass Transfer
1	**MEAM 348**	Mechanical Engineering Design Lab
1	Upper-level MEAM course	
1	Math elective, e.g., linear algebra, statistics	

Senior Year

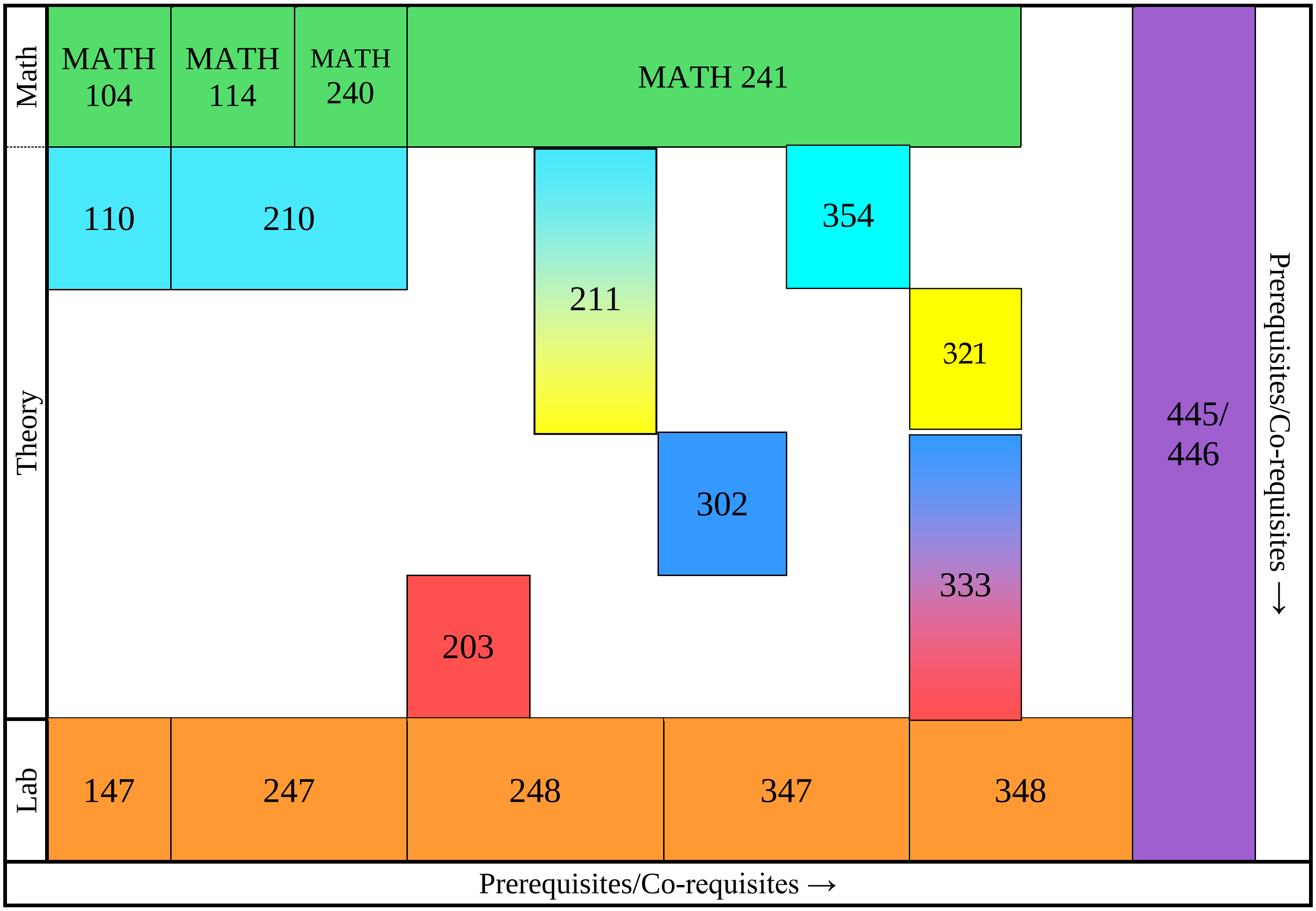
CUs	FALL	
1	**MEAM 445**	Mechanical Engineering Design Projects
1	Upper-level MEAM course	
1	Professional elective	
1	Social Science/Humanities/TBS elective	
1	Free elective	

CUs	SPRING	
1	**MEAM 446**	Mechanical Engineering Design Projects
1	Upper-level MEAM course	
1	Professional elective	
1	Social Science/Humanities/TBS elective	
1	Free elective	

Note: **Bold courses** are required MEAM courses.

MEAM CONCEPT FLOWCHART

This chart shows the connections between the concepts taught in the core MEAM courses.



Top to Bottom: Top courses are prerequisites or co-requisites for the courses underneath. Concepts from the courses on top are used in courses underneath.

Left to Right: Courses on the left are prerequisites or co-requisites for courses to their right. Concepts from the courses on the left are used in courses on the right.

MEAM ELECTIVE SCHEDULE

http://www.me.upenn.edu/current-students/undergraduates/elective-schedule.php

Fall 2014 Electives

MEAM 101	Introduction to Mechanical Design
MEAM 201	Machine Design and Manufacturing
MEAM 405/505	Mechanical Properties of Macro/Nanoscale Materials
MEAM 410/510	Design of Mechatronic Systems
MEAM 415, IPD 515, OPIM 415	Product Design (does not count for MEAM Upper Level)
MEAM 455, BE 455	Continuum Biomechanics
MEAM 502	Energy Engineering
MEAM 504	Tribology
MEAM 516, IPD 516	Advanced Mechatronics in Reactive Spaces
MEAM 520	Introduction to Robotics
MEAM 527, ENM 427	Finite Element Analysis
MEAM 530	Continuum Mechanics
MEAM 535	Advanced Dynamics
MEAM 545	Aerodynamics
MEAM 555, CBE 555, BE 555	Nanoscale Systems Biology
MEAM 564, ESE 460	Principles of Microfabrication Technology
MEAM 570	Transport Processes I
MEAM 575	Micro and Nano Fluidics
ENGR 105	Introduction to Scientific Computing
ENGR 250	Energy Systems, Resources and Technology
EAS 205	Applications of Scientific Computing
EAS 401/501	Energy and Its Impacts
EAS 545, IPD 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II

Tentative Spring 2015 Electives

MEAM 101	Introduction to Mechanical Design
MEAM 201	Machine Design and Manufacturing
MEAM 404	Materials in Mech. Design: Properties, Selection, and Processing
MEAM 415, IPD 515, OPIM 415	Product Design (does not count for MEAM Upper Level)
MEAM 513	Feedback Control Design and Analysis
MEAM 514, IPD 514	Design for Manufacturability
MEAM 620	Advanced Robotics
ENGR 105	Introduction to Scientific Computing
ENGR 250	Energy Systems, Resources and Technology
EAS 402/502	Renewable Energy and Its Impacts
EAS 545, IPD 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II
IPD 501	Integrated Computer-Aided Design

RECOMMENDED ELECTIVES outside of MEAM

BIOL 101	Introduction to Biology
BIOL 121	Introduction to Biology - The Molecular Biology of Life
BE 450	Hemodynamics
ESE 111	Atoms, Bits, Circuits, and Systems
ESE 215	Electrical Circuits and Systems
ESE 301	Engineering Probability
ESE 522	Manufacturing Operations Management
MSE 220	Engineering Materials
MSE 221	Quantum Physics of Materials
PHYS 280, BCHE 280	Biological Physics

AREAS OF SPECIALIZATION IN MECHANICAL ENGINEERING AND APPLIED MECHANICS

A student interested in pursuing certain engineering disciplines in depth should consider choosing his or her electives accordingly. Students are encouraged to specialize by taking courses in one or two of the areas listed below:

Energy Engineering

MEAM 502	Energy Engineering
MEAM 570	Transport
MEAM 572	Micro/Nanoscale Energy Transport
ENGR 250	Energy Systems, Resources & Technology
EAS 401/501	Energy and Its Impacts
EAS 402/502	Renewable Energy and Its Impacts

Fluid Mechanics and Aerodynamics

MEAM 245	Introduction to Flight
ENM 427/MEAM 527	Finite Elements and Applications
MEAM 513, ESE 406/505	Feedback Control Design and Analysis
MEAM 530	Continuum Mechanics
MEAM 545	Aerodynamics
MEAM 570	Transport

Manufacturing

MEAM 101	Introduction to Mechanical Design
MEAM 201	Machine Design and Manufacturing
MEAM 404	Materials in Mech. Design: Prop., Selection, and Proc.
MEAM 410/510	Design of Mechatronic Systems
MEAM 415, IPD 515, OPIM 415	Product Design
ENM 427/MEAM 527	Finite Element and Applications
MEAM 520	Introduction to Robotics
MEAM 550	Design of Microelectromechanical Systems
MEAM 564	Principles of Microfabrication Technology
ESE 215	Electrical Circuits and Systems
ESE 522	Process Management in Manufacturing

Mechatronics

MEAM 410/510	Design of Mechatronic Systems
MEAM 516	Advanced Mechatronics
MEAM 520	Introduction to Robotics
CIS 120	Introduction to Programming
ESE 215	Electrical Circuits and Systems
ESE 350	Embedded Systems/Microcontroller Laboratory

ESE 522	Process Management in Manufacturing

<u>Product Design and Innovation</u>

MEAM 101	Introduction to Computer Aided Design and Manufacturing
MEAM 201	Machine Design and Manufacturing
MEAM 404	Materials in Mech. Design: Prop., Selection, and Proc.
MEAM 410/510	Design of Mechatronic Systems
MEAM 415, IPD 515, OPIM 415	Product Design
MEAM 514, IPD 514	Design for Manufacturability
EAS 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II
ESE 400/540	Engineering Economics

<u>Structural Mechanics & Mechanics of Materials</u>

MEAM 404	Materials in Mech. Design: Prop., Selection, and Proc.
ENM 427/MEAM 527	Finite Element and Applications
MEAM 454/554	Mechanics of Materials
MEAM 519/MSE 550	Introduction to Elasticity
MEAM 530	Continuum Mechanics
MSE 220	Structural Materials

Note:

- Courses may not be offered every year.
- Students may consider designing an independent study course, MEAM 099, with a MEAM faculty advisor in any area or across two or more areas.

COURSE DESCRIPTIONS

L/L means lecture and lab
L/R means lecture and recitation
(A) means generally taught in the Fall
(B) means generally taught in the Spring
(C) means generally taught both Fall and Spring
(M) means taught only occasionally

099. Independent Study. (C) Open to all students. A maximum of 2 c.u. of MEAM 099 may be applied toward the B.A.S. or B.S.E. degree requirements.
An opportunity for the student to become closely associated with a professor in (1) a research effort to develop research skills and technique and/or (2) to develop a program of independent in-depth study in a subject area in which the professor and student have a common interest. The challenge of the task undertaken must be consistent with the student's academic level. To register for this course, the student and professor jointly submit a detailed proposal. Subject to the approval of the MEAM Undergraduate Curriculum Chair.

L/L 101. Introduction to Mechanical Design. (C) This course is available to all Engineering majors.
This hands-on, project-based course covers the fundamentals of the modern mechanical design process, from needfinding and brainstorming to the basics of computerized manufacturing and rapid prototyping. Topics include: product definition (needfinding, observation, sketching, and brainstorming); computer-aided design (part creation, assemblies, and animation using SolidWorks); fundamental engineering design practices (material selection, dimensioning, tolerances, etc.); basic computer simulation and analysis; and rapid prototyping (laser cutter, 3-D fused-deposition modeling, and an introduction to computer-controlled machining).

L/R 110. Introduction to Mechanics. (A) Corequisite(s): MATH 104 (The Engineering section of this class is strongly recommended) and MEAM 147.
This lecture course and a companion laboratory course (MEAM 147) build upon the concepts of Newtonian (classical) mechanics and their application to engineered systems. This course introduces students to mechanical principles that are the foundation of upper-level engineering courses including MEAM 210 and 211. The three major parts of this course are: I. Vector Mechanics; II. Statics and Structures; and III. Kinematics and Dynamics. Topics include: vector analysis, statics of rigid bodies, introduction to deformable bodies, friction, kinematics of motion, work and energy, and dynamics of particles. Case studies will be introduced, and the role of Newtonian mechanics in emerging applications including bio- and nano-technologies will be discussed.

147. Introduction to Mechanics Lab. (A) Corequisite(s): MEAM 110 or AP credit for Physics C, Mechanics.
This half-credit laboratory class is a companion to the Introduction to Mechanics lecture course (MEAM 110). It investigates the concepts of Newtonian (classical) mechanics through weekly hands-on experiments, emphasizing connections between theoretical principles and practical applications in engineering. In addition to furthering their understanding about the workings of the physical world, students will improve their skills at conducting experiments, obtaining reliable data, presenting numerical results, and extracting meaningful information from such numbers.

L/L 201. Machine Design and Manufacturing. (B) Prerequisite(s): MEAM 101 recommended, MEAM 210 or equivalent as co/pre-requisite (or permission of the instructor).
Building upon the fundamentals of mechanical design taught in MEAM 101, this hands-on, project-based course provides students with the knowledge and skills necessary to design, analyze, manufacture. and test fully-functional mechanical systems. Topics covered include an introduction to machine elements, analysis of the mechanics of machining, manufacturing technology, precision fabrication (milling, turning, and computer-controlled machining), metrology, tolerances, cutting-tool fundamentals and engineering materials. Enrollment is limited.

L/R 203. Thermodynamics I. (B) Prerequisite(s): Math 104 and Math 114.
Thermodynamics is the study of the fundamental concepts underlying the conversion of energy in such mechanical systems as internal and external combustion engines (including automobile and aircraft engines), compressors, pumps, refrigerators, and turbines. This course is intended for students in mechanical engineering, chemical engineering, materials science, physics and other fields. The topics include: Basic definitions, microscopic and macroscopic points of view; properties of pure substances and reversibility and irreversibility, the thermodynamic temperature scale, entropy, availability, second law analysis, power and refrigeration cycles and their engineering applications.

L/R 210. Statics and Strength of Materials. (A) Prerequisite(s): MEAM 110/147 or Physics 150. Corequisite(s): Math 240 and MEAM 247 are strongly recommended.
This course is intended for students in mechanical engineering, civil-systems, materials science, and other fields. It continues the treatment of the statics of rigid bodies begun in Physics 150 and MEAM 110 and leads to the treatment of deformable bodies and their response to loads. The concepts of stress, strain, and linearly elastic response are introduced and they are applied to the behavior of rods, beams, shafts and pressure valves. Safety factors and the onset of mechanical failure are discussed.

L/R 211. Engineering Mechanics: Dynamics. (B) Prerequisite(s): MEAM 210. Corequisite(s): MATH 241 or ENM 251 and EAS 105 or equivalent.
This course introduces the basic concepts in kinematics and dynamics that are necessary to understand, analyze and design mechanisms and machines. These concepts are also fundamental to the modeling and analysis of human movement, biomechanics, animation of synthetic human models and robotics. The topics covered include: Particle dynamics using energy and momentum methods of analysis; Dynamics of systems of particles; Impact; Systems of variable mass; Kinematics and dynamics of rigid bodies in plane motion; Computer-aided dynamic simulation and animation.

L/L 245. Introduction to Flight. (A) Prerequisite(s): PHYS 150 or MEAM 110/147. Corequisite(s): MATH 240. Basic concepts: pressure, density, velocity, forces. The standard atmosphere. Introduction to low speed aerodynamics. Airfoils, wings, and other aerodynamic shapes. Aircraft performance. Aircraft stability and control. Aircraft propulsion.

L/L 247. Mechanical Engineering Laboratory I. (A) Prerequisite(s): Sophomore standing in engineering. Corequisite(s): MEAM 210 strongly recommended.
This is the first of a two semester sophomore level laboratory sequence that students complete over the fall and spring semesters. The course teaches the principles of experimentation and measurement as well as analysis and application to design. This fall semester course follows closely with MEAM 210, involving experiments to explore the principles of statics and strength of materials.

L/L 248. Mechanical Engineering Lab I. (B) Prerequisite(s): Sophomore standing in engineering. Corequisite(s): MEAM 203 and MEAM 211 are strongly recommended.
This is the second of a two-semester sophomore level laboratory sequence that students complete over the fall and spring semesters. The course teaches the principles of experimentation and measurement as well as analysis and application to design. The spring semester course follows closely with MEAM 203 and MEAM 211, expanding upon the principles of experimentation, measurement, analysis, and design of systems through hands-on laboratories and projects in thermodynamics and dynamics.

L/R 302. Fluid Mechanics. (A) Prerequisite(s): MATH 241 or ENM 251 and PHYS 150 or MEAM 110/147.
Physical properties; fluid statics; Bernoulli equation; fluid kinematics; conservation laws and finite control-volume analysis; conservation laws and differential analysis; inviscid flow; The Navier-Stokes equation and some exact solutions; similitude, dimensional analysis, and modeling; flow in pipes and channels; boundary layer theory; lift and drag.

L/R 321. Vibrations of Mechanical Systems. (A) Prerequisite(s): MATH 241 or ENM 251 and MEAM 211.
This course teaches the fundamental concepts underlying the dynamics of vibrations for single-degree of freedom, multi-degree and infinite-degree of freedom mechanical systems. The course will focus on Newton's Force Methods, Virtual-Work Methods, and Lagrange's Variation Methods for analyzing problems in vibrations. Students will learn how to analyze transient, steady state and forced motion of single and multi-degree of freedom linear and non-linear systems. The course teaches analytical solution techniques for linear systems and practical numerical and simulation methods for analysis and design of nonlinear systems.

L/R 333. Heat and Mass Transfer. (B) Prerequisite(s): MEAM 203 and MEAM 302.
This course covers fundamentals of heat and mass transfer and applications to practical problems in energy conversion and conservation. Emphasis will be on developing a physical and analytical understanding of conductive, convective, and radiative heat transfer, as well as design of heat exchangers and heat transfer with phase change. Topics covered will include: types of heat transfer processes, their relative importance, and the interactions between them, solutions of steady state and transient state conduction, emission and absorption of radiation by real surfaces and radiative transfer between surfaces, heat transfer by forced and natural convection owing to flow around bodies and through ducts, analytical solutions for some sample cases and applications of correlations for engineering problems. Students will develop an ability to apply governing principles and physical intuition to solve problems.

L/L 347. Mechanical Engineering Design Laboratory. (A) Prerequisite(s): Junior standing in engineering.
This is a junior level laboratory course. The course teaches the principles of design and measurement systems including basic electromechanical systems. It follows MEAM 302 and MEAM 321 including experiments in fluid mechanics, and vibration in the design of mechanical systems.

L/L 348. Mechanical Engineering Design Laboratory. (B) Prerequisite(s): Junior standing in engineering.
This course is a junior lab which follows MEAM 333 Heat Transfer and MEAM 354 Mechanics of Materials with design projects based on those topics. In the broader context of design/independent skill development, this course also introduces open ended topics, wider design options, and introduces project planning and management.

L/R 354. Mechanics of Solids. (B) Prerequisite(s): MEAM 210 or equivalent, BE200 or permission of instructor.
This course builds on the fundamentals of solid mechanics taught in MEAM 210 and addresses more advanced problems in strength of materials. The students will be exposed to a wide array of applications from traditional engineering disciplines as well as emerging areas such as biotechnology and nanotechnology. The methods of analysis developed in this course will form the cornerstone of machine design and also more advanced topics in the mechanics of materials.

404. Materials in Mechanical Design: Properties, Selection, and Processing. (A) (Tentative)
The application of continuum and microstructural concepts to consideration of the mechanics and mechanisms of flow and fracture in metals, polymers and ceramics. The course includes a review of tensors and elasticity with special emphasis on the effects of symmetry on tensor properties. Then deformation, fracture and degradation (fatique and wear) are treated, including mapping strategies for understanding the ranges of material properties.

405. (MEAM505, MSE 405, MSE 505) Mechanical Properties of Macro/Nanoscale Materials. (A)
This course covers materials concepts that are essential in mechanical design. The properties, selection, and processing of a wide range of materials (including metals, ceramics, polymers, composites) are examined from both a fundamental and practical perspective. The relationship of material properties to bonding and microstructure of materials are discussed. An emphasis is placed on mechanical properties of materials, including modulus, strength, fracture, fatigue, wear, and creep. Design-based case studies are used to illustrate the selection of materials and processes.

L/L 410. (MEAM510) Design of Mechatronic Systems. (A) Prerequisite(s): Junior or Senior standing in MEAM and a first course in Programming.
In many modern systems, mechanical elements are tightly coupled with electronic components and embedded computers. Mechatronics is the study of how these domains are interconnected, and this hands-on, project-based course provides an integrated introduction to the fundamental components within each of the three domains, including: mechanical elements (prototyping, materials, actuators and sensors, transmissions, and fundamental kinematics), electronics(basic circuits, filters, op amps, discrete logic, and interfacing with mechanical elements), and computing (interfacing with the analog world, microprocessor technology, basic control theory, and programming).

415. (IPD 515) Product Design. (C)
This course provides tools and methods for creating new products. The course is intended for students with a strong career interest in new product development, entrepreneurship, and/or technology development. The course follows an overall product design methodology, including the identification of customer needs, generation of product concepts, prototyping, and design-for-manufacturing. Weekly student assignments are focused on the design of a new product and culminate in the creation of a prototype. The course is open to juniors and seniors in SEAS or Wharton.

445. Mechanical Engineering Design Projects. (A) Prerequisite(s): Junior standing.
This is a capstone design project course in mechanical engineering and is required of all mechanical engineering students. Students will be involved in selected group or individual projects emphasizing design, development, and experimentation, under the supervision of a MEAM faculty advisor. Projects are sponsored either by industry or by Penn professors. Alternatively, students may propose their own projects. Each project is approved by the instructor and the faculty advisor. The work is spread over MEAM 445 and MEAM 446. In addition to being involved in the design project, MEAM 445 covers project planning, patent and library searches, professional education, ethics, writing skills, communication, and technical presentation.

446. Mechanical Engineering Design Projects. (B)
This is the second course in the two course sequence involving the capstone design project. See MEAM 445.

454. (MEAM554) Mechanics of Materials. (B) Prerequisite(s): MEAM 210 and/or MEAM 354, MATH 240, 241 or ENM 251.
This course is an upper level course that discusses the behavior of materials, the selection of materials in mechanical components, and the mechanics of deformable bodies. It is intended for students interested in material science, mechanical engineering, and civil engineering. The topics covered include: Stress. Strain. Principal Stresses. Compatibility. Elastic stress-strain relations. Strain energy. Plane strain. Plane stress. Rods and trusses. Bending of beams. Torsion. Rotating disks. Castigliano's Theorem. Dummy loads. Principle of virtual work. The Rayleigh-Ritz Methods. Introduction to the finite element method. Non-linear material behavior. Yielding. Failure.

455. (BE 455, MEAM544) Continuum Biomechanics. (A)
Continuum mechanics with applications to biological systems. Fundamental engineering conservation laws are introduced and illustrated using biological and non-biological examples. Kinematics of deformation, stress, and conservation of mass, momentum, and energy. Constitutive equations for fluids, solids, and intermediate types of media are described and applied to selected biological examples. Class work is complemented by hands-on experimental and computational laboratory experiences.

502. Energy Engineering. (A) Prerequisite(s): MEAM 203 or equivalent, and MEAM 333 or equivalent (could be taken concurrently with MEAM 402).
Quantitative introduction to the broad area of energy engineering, from basic principles to applications. The focus is on the science and engineering of power generation. The course includes a review of energy resources and consumption, power cycles, combined cycles, and co-generation, nuclear energy and wastes, solar thermal and photovoltaic energy, and wind power. Additional energy conversion topics including energy storage and geothermal, thermoelectric, hydroelectric and biomass power will be briefly discussed.

504. Tribology. (C) Prerequisite(s): Senior standing in Mechanical Engineering or Materials Science or by permission of the instructor.
The course will comprehensively cover both theoretical and practical tribology, the science and technology of interacting surfaces in relative motion. The various modes of lubrication, hydrodynamic, elastohydradynamic, hydrostatic, mixed, solid and dry, will be studied in detail. The contact between solid surfaces will be covered, leading to an understanding of friction and various modes of wear. At each stage, it will be shown how the tribological principles learned can be applied in practice to improve the efficiency and durability of mechanical equipment and thereby enhance sustainability through energy and materials conservation.

513. (ESE 406, ESE 505) Feedback Control Design and Analysis. (B) Prerequisite(s): MEAM 321 or ESE 210, Juniors and Seniors encouraged to enroll.
Basic methods for analysis and design of feedback control in systems. Applications to practical systems. Methods presented include time response analysis, frequency response analysis, root locus, Nyquist and Bode plots, and the state-space approach.

514. (IPD 514) Design for Manufacturability. (B) Prerequisite(s): MEAM 101 or equivalent, MEAM 210 or equivalent, Senior or Graduate standing in the School of Design, Engineering, or Business with completed product development and/or design engineering core coursework or related experience.
This course is aimed at providing current and future product design/development engineers, manufacturing engineers, and product development managers with an applied understanding of Design for Manufacturability (DFM) concepts and methods. The course content includes materials from multiple disciplines including: engineering design, manufacturing, marketing, finance, project management, and quality systems.

L/L 516. (IPD 516) Advanced Mechatronic Reactive Spaces. (B)
This course teaches advanced mechatronics concepts that include the design and implementation of networked embedded systems, large-scale actuation, advanced sensing and control. This course pairs design school and engineering students to form interdisciplinary teams that together design and build electro-mechanical reactive spaces and scenic/architectural elements in the context of the performing arts. The two disciplinary groups will be treated separately and receive credit for different courses (ARCH746 will be taught concurrently and in some cases co-located) as they will be learning different things. Engineering students gain design sensibilities and advanced mechatronics in the form of networked embedded processing and protocols for
large scale actuation and sensing. Design students learn elementary mechatronics and design reactive architectures and work with engineering students to build them. The class will culminate in a collection of short performance pieces inspired by Shakespeare's A Midsummer Night's Dream with both mechatronic and human performers from the Pig Iron Theater Troupe.

A final paper will be required that is ready for conference proceedings.

519. (MSE 550) Elasticity and Micromechanics of Materials. (C)
This course is targeted to engineering students working in the areas on micro/nanomechanics of materials. The course will start with a quick review of the equations of linear elasticity and proceed to solutions of specific problems such as the Hertz contact problem, Eshelby's problem etc. Failure mechanisms such as fracture and the fundamentals of dislocations/plasticity will also be discussed.

520. Introduction to Robotics. (A) Prerequisite(s): MEAM 211 and MATH 240 or equivalent.
The rapidly evolving field of robotics includes systems designed to replace, assist, or even entertain humans in a wide variety of tasks. Recent examples include planetary rovers, robotic pets, medical surgical-assistive devices, and semi-autonomous search- and-rescue vehicles. This introductory-level course presents the fundamental kinematic, dynamic, and computational principles underlying most modern robotic systems. The main topics of the course include: coordinate transformations, manipulator kinematics, mobile-robot kinematics, actuation and sensing, feedback control, vision, and motion planning. The material is reinforced with hands-on lab exercises including robot-arm control and the programming of vision-guided mobile robots.

L/R 527. (ENM 427) Finite Element Analysis. (A) Prerequisite(s): MATH 241 or ENM 251 and PHYS 151.
The objective of this course is to equip students with the background needed to carry out finite elements-based simulations of various engineering problems. The first part of the course will outline the theory of finite elements. The second part of the course will address the solution of classical equations of mathematical physics such as Laplace, Poisson, Helmholtz, the wave and the Heat equations. The third part of the course will consist of case studies taken from various areas of engineering and the sciences on topics that require or can benefit from finite element modeling. The students will gain hand-on experience with the multi-physics, finite element package FemLab.

530. Continuum Mechanics. (A) Prerequisite(s): Multivariable Calculus, Linear Algebra, Partial Differential Equations.
This course serves as a basic introduction to the Mechanics of continuous media, and it will prepare the student for more advanced courses in solid and fluid mechanics. The topics to be covered include: Tensor algebra and calculus, Lagrangian and Eulerian kinematics, Cauchy and Piola-Kirchhoff stresses, General principles: conservation of mass, conservation of linear and angular momentum, energy and the first law of thermodynamics, entropy and the second law of thermodynamics; constitutive theory, ideal fluids, Newtonian and non-Newtonian fluids, finite elasticity, linear elasticity, materials with microstructure.

535. Advanced Dynamics. (A)
Rigid body kinematics; Newtonian formulations of laws of motion; concepts of momentum, energy and inertia properties; generalized coordinates, holonomic and nonholonomic constraints. Generalized forces, principle of virtual work, D'Alembert's principle. Lagrange's equations of motion and Hamilton's equations. Conservation laws and integrals of motion. Friction, impulsive forces and impact. Applications to systems of rigid bodies.

536. Viscous Fluid Flow and Modern Applications. (M) This course is intended for juniors, seniors and graduate students from the Schools of Engineering and/or Arts and Sciences that have a general interest in fluid dynamics and its modern applications. Students should have an understanding of basic concepts in fluid mechanics and a good grasp on differential equations. This is an intermediate course that builds on the basic principles of Fluid Mechanics. The course provides a more in depth and unified framework to understand fluid flow at different time and length scales, in particular viscous flows. Topics include review of basic concepts, conservation laws (momentum, mass, and heat), fluid kinematics, tensor analysis, Stokes' approximations, non- Newtonian fluid mechanics, and turbulence. The course will explore important modern topics such as microfluidics, swimming of micro-organisms, wind turbines, rheology, biofluid mechanics, and boundary layers.

537. (MSE 537) Nanomechanics and Nanotribology at Interfaces. (B) Prerequisite(s): Freshman physics; MEAM 354 or equivalent, or consent of instructor.
Engineering is progressing to ever smaller scales, enabling new technologies, materials, devices, and applications. This course will provide an introduction to nano-scale mechanics and tribology at interfaces, and the critical role these topics play in the developing area of nanoscience and nanotechnology. We will discuss how mechanics and tribology at interfaces become integrated with the fields of materials science, chemistry, physics, and biology at this scale. We will cover a variety of concepts and applications, drawing connections to both established and new approaches. We will discuss the limits of continuum mechanics and present newly developed theories and experiments tailored to describe micro- and nano-scale phenomena. We will emphasize specific applications throughout the course. Literature reviews, critical peer discussion,

individual and team problem assignments, and a peer reviewed literature research project will be assigned as part of the course.

545. Aerodynamics. (B) Prerequisite(s): MEAM 302. Review of fluid kinematics and conservation laws; vorticity theorems; two-dimensional potential flow; airfoil theory; finite wings; oblique shocks; supersonic wing theory; laminar and turbulent boundary layers.

550. Design of Microelectromechanical Systems. (M) Prerequisite(s): MEAM 354 or equivalent is recommended. A course that covers the design and fabrication of micro- and nano-electromechanical systems. Topics in the course include micro- and nano-fabrication techniques, mechanics of flexures, thin film mechanics, sensing and actuation approaches (e.g., electrostatic, plezoelectric, and piezoresistive), as well as materials and reliability issues. The fundamentals of these topics will be augmented with device-based case studies.

L/R 555. (BE 555, CBE 555) Nanoscale Systems Biology. (C) Prerequisite(s): Background in Biology, Chemistry or Engineering with coursework in thermodynamics or permission of the instructor.
From single molecule studies to single cell manipulations, the broad field of cell and molecular biology is becoming increasingly quantitative and increasingly a matter of systems simplification and analysis. The elaboration of various stresses on cellular structures, influences of interaction pathways and convolutions of incessant thermal motions will be discussed via lectures and laboratory demonstration. Topics will range from, but are not limited to, protein folding/forced unfolding to biomolecule associations, cell and membrane mechanics, and cell motility, drawing from very recent examples in the literature. Frequent hands-on exposure to modern methods in the field will be a significant element of the course in the laboratory. Skills in analytical and professional presentations, papers and laboratory work will be developed.

L/R 561. Thermodynamics: Foundations, Energy, Materials. (M) Prerequisite(s): Undergraduate thermodynamics. To introduce students to advanced classical equilibrium thermodynamics based on Callen's postulatory approach, to exergy (Second-Law) analysis, and to fundamentals of nonequilibrium thermodynamics. Applications to be treated include the thermodynamic foundations of energy processes and systems including advanced power generation and aerospace propulsion cycles, batteries and fuel cells, combustion, diffusion, transport in membranes, materials properties and elasticity, superconductivity, biological processes.

L/L 564. (ESE 460, ESE 574) The Principles and Practice of Microfabrication Technology. (A) Prerequisite(s): Any of the following courses: ESE 218, MSE 321, MEAM 333, CHE 351, CHEM 321/322, Phys 250 or permission of the instructor.
A laboratory course on fabricating microelectronic and micromechanical devices using photolithographic processing and related fabrication technologies. Lectures discuss: clean room procedures, microelectronic and microstructural materials, photolithography, diffusion, oxidation, materials deposition, etching and plasma processes. Basic laboratory processes are covered in the first two thirds of the course with students completing structures appropriate to their major in the final third. Students registering for ESE 574 will be expected to do extra work (including term paper and additional project).

L/R 570. (CBE 640) Transport Processes I. (A)
The course provides a unified introduction to momentum, energy (heat), and mass transport processes. The basic mechanisms and the constitutive laws for the various transport processes will be delineated, and the conservation equations will be derived and applied to internal and external flows featuring a few examples from mechanical, chemical, and biological systems. Reactive flows will also be considered.

572. Micro/Nanoscale Energy Transport. (M) Prerequisite(s): Undergraduate thermodynamics and heat transfer (or equivalent), or permission of the instructor. Undergraduates my enroll with permission of the instructor.
As materials and devices shrink to the micro- and nanoscale, they transmit heat, light and electronic energy much differently than at the macroscopic length scales. This course provides a foundation for studying the transport of thermal,optical, and electronic energy from a microscopic perspective. Concepts from solid state physics and statistical mechanics will be introduced to analyze the influence of small characteristic dimensions on the propagatin of crystal vibratins, electrons, photons, and molecules. Applications to mdern microdevices and therometry techniques will be discussed. Topics to be covered include natural and fabricated microstructures, transport and scattering of phonons and electrons in solids, photon-phonon and photon-electron interactions, radiative recombinations, elementary kinetic theory, and the Boltzmann transport equation.

575. Micro and Nano Fluidics. (M)

The course will focus on a few topics relevant to micro-fluidics and nano-technology. In particular, we will learn how the solid liquid interface acquires charge and the role that this charge plays in colloid stability, electroosmosis, and electrophoresis. Other topics will include controlled nano-assembly with dielectrophoresis, and stirring at very low Reynolds numbers (Lagrangian Chaos). The focus of the course will be on the physical phenomena from the continuum point of view. The mathematical complexity will be kept to a minimum. Software tools such as Maple and Femlab will be used throughout the course. The course will be reasonably self- contained and necessary background material will be provided consistent with the students' level of preparation.

PRIMARY FACULTY IN MECHANICAL ENGINEERING AND APPLIED MECHANICS

As of 8/19/14

Paulo E. Arratia, Associate Professor
Office: 271 Towne Phone: 215-746-2174 Email: parratia@seas

Micro- and Nanofluidics, Complex Fluids such as polymeric & biological materials, Transport Phenomena with emphasis on fluid & nonlinear dynamics, Rheology, and Soft-Condensed Matter including granular media.

Portonovo S. Ayyaswamy, Asa Whitney Professor of Dynamical Engineering
Office: 231 Towne Phone: 215-898-8362 Email: ayya@seas.upenn.edu

Phase change heat and mass transfer processes, bioheat/mass transfer, arc-plasma heat transfer, thermal aspects in MEMS.

Igor Bargatin, Class of 1965 Term Assistant Professor
Office: 277 Towne Phone: 215-746-4887 Email: bargatin@seas.upenn.edu

Micro- and nanomechanics, thermal sciences and energy conversion, mechanics of materials.

John L. Bassani, Richard H. and S.L. Gabel Professor of Mechanical Engineering
Office: 237 Towne Phone: 898-5632 Email: bassani@seas.upenn.edu

Plastic deformation of crystals, atomic/continuum property relationships, interface mechanics, fracture mechanics, material stability at large strains, mechanics of living cells.

Haim H. Bau, Professor
Office: 233 Towne Phone: 215-898-8363 Email: bau@seas.upenn.edu

Bifurcation and instability phenomena in and feedback control of flows, transport phenomena in micron and submicron size structures, meso- and microelectromechanical systems.

Robert Carpick, John Henry Towne Professor and Department Chair
Office: 251 Towne Phone: 215-898-4608 Email: carpick@seas.upenn.edu

Experimental nanomechanics and nanotribology (friction, adhesion, lubrication, wear). Development, characterization, and applications of nanostructured materials. Application and development of advanced scanning force microscopy tools.

Howard H. Hu, Professor
Office: 241 Towne Phone: 215-898-8504 Email: hhu@seas.upenn.edu

Modeling of complex flows with multiphase or polymeric fluids, computational fluid dynamics, hydrodynamic stability.

Katherine J. Kuchenbecker, Associate Professor and Undergraduate Curriculum Chair
Office: 224 Towne Phone: 215-573-2786 Email: kuchenbe@seas.upenn.edu

Haptic (touch-based) interaction, design and control of haptic interfaces for virtual environments and teleoperation, identification of dynamic systems, understanding human upper-limb movement, and developing medical devices and medical robotic systems.

Vijay Kumar, UPS Foundation Professor
Office: 470 Levine Phone: 215-898-3630 Email: kumar@seas.upenn.edu

Robotics, dynamics of systems with frictional contacts, actively coordinated mobility systems, mechanism design and control.

Noam Lior, Professor
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Heat transfer and fluid mechanics, thermodynamics and Second-Law analysis, energy conversion, solar energy, combustion, flash evaporation and water desalination, destruction of hazardous wastes by photocatalysis and supercritical oxidation, heat treatment.

Jennifer R. Lukes, Associate Professor
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Molecular dynamics simulation, molecular mechanical engineering, micro/nanoscale heat transfer.

Pedro Ponte Castañeda, Raymond S. Markowitz Faculty Fellow and Professor
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Nonlinear composite materials, fracture mechanics, microstructure evolution and localization in manufacturing processes, nonlinear variational principles in mechanics.

Prashant Purohit, Associate Professor and Graduate Group Chair
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Rod theories for DNA and biopolymers, mechanics of sub-cellular organelles, mechanics at the bio-nano interface, martensitic phase transitions in solids.

Celia Reina, William K. Gemmill Term Assistant Professor
Office: 275 Towne Phone: 215-898-9258 Email: creina@seas.upenn.edu

Computational Mechanics, Mechanics of Materials, Micro- and Nanomechanics

David J. Srolovitz, Joseph Bordogna Professor of Engineering and Applied Science (in MEAM and MSE); Director of the Penn Center of Excellence in Advanced Computation
Office: 409 LRSM Phone: 215-898-6924 Email: srol@seas.upenn.edu

Computational and theoretical materials science, defects, growth, evolution and deformation of materials

Kevin Turner, Gabel Family Term Associate Professor of Mechanical Engineering
Office: 245 Towne Phone: 215-573-7485 Email: kturner@seas.upenn.edu

Development and understanding of micro/nanoscale manufacturing processes, experimental and computational fracture and contact mechanics, small-scale adhesion mechanics, micro/nanoelectromechanical systems, mechanics of biological interfaces and cells

Mark Yim, Professor and Director of the Integrated Product Design Program
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Modular reconfigurable robots and locomotion, PolyBot; MEMS and batch fabrication techniques; brute force digital time optimal control.

AFFILIATED FACULTY AND LECTURERS

As of 8/19/14

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Graham Wabiszewski, Lecturer
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ADMINISTRATIVE STAFF

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Maryeileen B. Griffith, Associate Director of Graduate Programs
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Sue Waddington Pilder, Office Manager and Assistant to the Chair
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TECHNICAL STAFF

As of 8/19/14

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Peter Szczesniak, Manager, Manufacturing and Fabrication Services
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University of Pennsylvania's Code of Academic Integrity

http://www.upenn.edu/academicintegrity/ai_codeofacademicintegrity.html

Since the University is an academic community, its fundamental purpose is the pursuit of knowledge. Essential to the success of this educational mission is a commitment to the principles of academic integrity. Every member of the University community is responsible for upholding the highest standards of honesty at all times. Students, as members of the community, are also responsible for adhering to the principles and spirit of the following Code of Academic Integrity.*

Academic Dishonesty Definitions

Activities that have the effect or intention of interfering with education, pursuit of knowledge, or fair evaluation of a student's performance are prohibited. Examples of such activities include but are not limited to the following definitions:

A. Cheating Using or attempting to use unauthorized assistance, material, or study aids in examinations or other academic work or preventing, or attempting to prevent, another from using authorized assistance, material, or study aids. Example: using a cheat sheet in a quiz or exam, altering a graded exam and resubmitting it for a better grade, etc.

B. Plagiarism Using the ideas, data, or language of another without specific or proper acknowledgment. Example: copying another person's paper, article, or computer work and submitting it for an assignment, cloning someone else's ideas without attribution, failing to use quotation marks where appropriate, etc.

C. Fabrication Submitting contrived or altered information in any academic exercise. Example: making up data for an experiment, fudging data, citing nonexistent articles, contriving sources, etc.

D. Multiple Submissions Submitting, without prior permission, any work submitted to fulfill another academic requirement.

E. Misrepresentation of Academic Records Misrepresenting or tampering with or attempting to tamper with any portion of a student's transcripts or academic record, either before or after coming to the University of Pennsylvania. Example: forging a change of grade slip, tampering with computer records, falsifying academic information on one's resume, etc.

F. Facilitating Academic Dishonesty Knowingly helping or attempting to help another violate any provision of the Code. Example: working together on a take-home exam, etc.

G. Unfair Advantage Attempting to gain unauthorized advantage over fellow students in an academic exercise. Example: gaining or providing unauthorized access to examination materials, obstructing or interfering with another student's efforts in an academic exercise, lying about a need for an extension for an exam or paper, continuing to write even when time is up during an exam, destroying or keeping library materials for one's own use., etc.

* If a student is unsure whether his or her action(s) constitute a violation of the Code of Academic Integrity, then it is that student's responsibility to consult with the instructor to clarify any ambiguities.