2018-19 Senior Design projects
467ME- 487AERO

Professor Bai B5

Professor Bai B1 487

Professor Baruh B3

Professor Baruh B4

Professor Bottega B9

Wind Walkers

The section will be divided into 2 groups. The 2 groups of 5 will design, build and compete for the fastest and most efficient wind driven walking machine under a given range of including sizes and materials. The two designs will compete at the end of the academic year. They will race over a specified distance and course.

Professor Bottega BW

Wind Walkers

The section will be divided into 2 groups. The 2 groups of 5 will design, build and compete for the fastest and most efficient wind driven walking machine under a given range of including sizes and materials. The two designs will compete at the end of the academic year. They will race over a specified distance and course.

Please contact Professor Bilgen regarding groups that will be running this semester

Professor Bilgen B/A

For MAE 467 and 487: Multi-disciplinary Team - 5 AE and/or 5 ME Students

Multi-Mode Hybrid Unmanned Delivery System: Combining Fixed-Wing and Multi-Rotor Aircraft with Ground Vehicles

The goal of this project is to investigate novel concepts for a multi-mode unmanned aerial system. For example, a VTOL vehicle attached (docked) to a fixed-wing (i.e. STOL) vehicle. In this case, the fixed-wing aircraft does the long-distance “cruising.” Once the system within the vicinity of the delivery location, the multi-rotor will detach and will take care of the vertical movement for a controlled delivery to the ground. Navigation, planning, logistics, policy issues, docking/undocking, platforms etc. are all very interesting and relevant problems – such issues will be looked at by the design team. A multi-disciplinary senior-design team is anticipated.

The students should be very comfortable with at least one of the following: 1) Design and analysis software such as Matlab, Xfoil, AVL, Ansys, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors,
op-amps, microcontrollers (i.e. Arduino), simple wiring, etc.; 3) Fabrication techniques such as 3D printing, bonding, vacuum bagging, manual fabrication, etc.

All team members are expected to have an exceptional work ethic and dedication to the project. Students having a high course load in their senior year should consult Dr. Bilgen before applying. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email to arrange a tour of the Smart Systems Laboratory.

Professor Bilgen B/B
For MAE 467: 5 ME Students
Energy Harvesting and Structural Health Monitoring for the Rutgers Football Stadium

The goal of this project is the design, analysis, fabrication and testing of a smart material based energy harvesting and structural health monitoring system for the Rutgers Football Stadium (as well as for other civil structures such as wind turbines, bridges and buildings.) The team will utilize piezoelectric materials and other types of devices to sense and harvest environmental energy. The team will design, fabricate and test several different iterations of various devices as well as power/sensing electronics and control algorithms. The prototypes will be tested on the Rutgers Football Stadium.

The students should be very comfortable with at least one of the following: 1) Design and analysis software such as Matlab, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors, op-amps, microcontrollers (i.e. Arduino), simple wiring, etc.; 3) Fabrication techniques such as 3D printing, bonding, vacuum bagging, manual fabrication, etc.

All team members are expected to have an exceptional work ethic and dedication to the project. Students having a high course load in their senior year should consult Dr. Bilgen before applying. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email to arrange a tour of the Smart Systems Laboratory.

Professor Bilgen B/C
For MAE 467 and 487: Multi-disciplinary Team - 5 AE and/or 5 ME Students
A Novel Quad-Copter “Drone” with Solid-State Rotors

The goal of this project is the design, analysis, fabrication and testing of a small quad-copter unmanned aerial vehicle (UAV) that utilizes smart materials to achieve control and improvement of performance of its rotor blades. The team will design, fabricate and test multiple iterations of the solid-state rotors as well as power/sensing electronics and control algorithms. The prototypes will be implemented on a quad-copter for demonstration purposes.

The students should be very comfortable with at least one of the following: 1) Design and analysis software such as Matlab, XROTOR, XFOIL, AVL, Ansys, Fluent, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors, op-amps, microcontrollers (i.e. Arduino), simple wiring, etc.; 3) Fabrication techniques such as 3D printing, bonding, vacuum bagging, manual fabrication, etc.
All team members are expected to have an exceptional work ethic and dedication to the project. Students having a high course load in their senior year should consult Dr. Bilgen before applying. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email to arrange a tour of the Smart Systems Laboratory.

Similar working models can be seen at the YouTube link below: [ http://www.youtube.com/watch?v=KxTJBp53nO0 ]

**Professor Bilgen B/D**  
*For MAE 467 and 487: Multi-disciplinary Team - 5 AE and/or 5 ME Students*  
**Design and Testing of a Small Scale Smart-Material Based Solid-State Aircraft**

This is a multi-disciplinary project based on the design, analysis and testing of a small solid-state ornithopter that uses only smart materials to achieve flight. The students will design, fabricate and test several different iterations of the smart material based composite aircraft as well as power/sensing electronics and control algorithms.

No aircraft design background required; however the students should be comfortable with at least one of the following: Design and analysis software (MatLab, XFOIL, AVL, Ansys, Fluent, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.), simple analog and digital electronics (resistors, capacitors, op-amps, microcontrollers, simple wiring, etc.), fabrication techniques (bonding, vacuum bagging, manual fabrication, etc.).

All team members are expected to have an exceptional work ethic and dedication to the project. Students having a high course load in their senior year should consult Dr. Bilgen before applying. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email to arrange a tour of the Smart Systems Laboratory.

Similar working models can be seen at the YouTube link below: [ http://www.youtube.com/watch?v=KxTJBp53nO0 ]

**Professor Bilgen B/E**  
*For MAE 467: 5 ME Students*  
**A Solid-State Fully-Active Smart-Material Based Prosthetic Arm**

This is a multi-disciplinary project based on the design, analysis and testing of a solid-state smart material based prosthetic arm. The students will utilize a piezoelectric sensor to control a shape-memory alloy actuated solid-state prosthetic device. The prosthetic device will consist of solid-state smart-materials and will not have any conventional mechanical devices such as motors, linkages or gears. The students will design, fabricate and test several different iterations of the structure as well as power/sensing electronics and control algorithms. This project will complement current research within the medical field.

No specific subject background required, however students should be comfortable with design and analysis software (MatLab, Comsol, Ansys, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.), simple analog and digital electronics (resistors, capacitors, op-amps, microcontrollers, Arduino, simple wiring, etc.), fabrication techniques (bonding, vacuum bagging, manual fabrication, etc.).
All team members are expected to have an exceptional work ethic and dedication to the project. Students having a high course load in their senior year should consult Dr. Bilgen before applying. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email to arrange a tour of the Smart Systems Laboratory.

**Professor Callegari C1**

**Professor Cuitino C3**

**Professor DeMauro D7 closed**

*GoFly Competition* (Closed project; membership is already set)

**Professor DeMauro D1 closed**

**Delta Wing**: Group will be required to build and fly a working delta wing airplane. The delta wing will be controlled from the ground and will be required to takeoff, land, and perform a coordinated turn. The first semester will specifically focus on the design and analysis work; the second semester will focus on building each plane. By the end of the first semester, the groups are expected to produce detailed working drawings, 3D CAD drawings, and a 3D assembly drawing. Tolerances must be provided on the working drawings. The major requirements for the aircraft are:

a. Fixed delta wing  
b. Provide justification for the selection of the wing airfoil shape  
c. Take-off and land under its own power  
d. Can perform a coordinated turn  
e. The wingspan of the aircraft cannot be larger than 4 feet

The mission profile for the plane includes taxi, takeoff, climb, cruise, descent, and landing, with at least one turn. The plane will be judged based on how it meets the criteria, maximum weight, flight speed, etc., and the total budget. Also, justifications must be provided for design choices, such as airfoil selection, aspect ratio, tail design, etc. Groups are expected to give weekly project updates via PowerPoint. It is highly encouraged that students have taken are will be taking aerodynamics and flight dynamics.
Professor Denda D1
Bio-Inspired Flapping Wing Energy Harvester
Prof. M. Denda
Built on the latest in flapping flight research, the patent-pending technology at the core of this project has been shown to produce efficiencies higher than the best wind turbines on the market.
How? Recently, scientists discovered that birds use advanced flapping aerodynamics to move through the air up to 5 times more efficiently than man-made aircraft. The goal of this project is to use these recently discovered phenomena to efficiently harvest energy from the wind. Team members will design and construct their own wind energy harvester, then test its performance under different conditions. They will have access to CAD models of working prototypes that have been previously built and tested, and they will also have access to proprietary MATLAB programs which can predict efficiency before building the device.
Prerequisites: Hands on mechanical experience.
Other Recommended Skills: SolidWorks, Programming, Machining

Professor Denda D2
Bio-Inspired Flapping Wing Energy Harvester
Prof. M. Denda
Built on the latest in flapping flight research, the patent-pending technology at the core of this project has been shown to produce efficiencies higher than the best wind turbines on the market.
How? Recently, scientists discovered that birds use advanced flapping aerodynamics to move through the air up to 5 times more efficiently than man-made aircraft. The goal of this project is to use these recently discovered phenomena to efficiently harvest energy from the wind. Team members will design and construct their own wind energy harvester, then test its performance under different conditions. They will have access to CAD models of working prototypes that have been previously built and tested, and they will also have access to proprietary MATLAB programs which can predict efficiency before building the device.
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Professor Diez D3

Professor Diez D2 650:487

Professor Drazer D5

Professor Drazer D6

Professor Guo G3

Building Devices for Harvesting Solar Energy and Desalination

The amount of solar irradiation on earth’s surface is gigantic, but most of which remains unutilized while we keep depleting traditional fossil fuels. Photovoltaic (PV) or solar cells convert light energy into electricity. The yearly installation capacity of solar photovoltaic facilities has
seen a continuous significant increase worldwide in recent years. Solar energy is also used for natural illumination and water and space heating. 97% of the water on the Earth is salt water. Water scarcity is among the major problems to be faced by human beings. Solar desalination is a technique to desalinate water using solar energy.

In this project, you could bring in some “wild” ideas to design and build a device for solar energy harvesting or for solar desalination. For example, you may consider harvest solar energy for illumination and water heating via a smart window, build a small solar cell power generator, or design a solar desalination device. The objective of this project is to design, build, and analyze a device for solar energy harvesting or water desalination for engineering practice of natural renewable resources.

**Professor Guo G4**

Building Devices for Harvesting Solar Energy and Desalination

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**Professor Knight K1 650:487**

Design of Model Rocket Engine Thrust Stand
Introduction and Eligibility
There will be two groups (K1 and K2) with a maximum of five students per group. Groups K1 and K2 are open to Aerospace Engineering majors only.
Design Project
Each group will design a tabletop test stand for measuring the thrust of a model rocket engine.
Conceptual Design
A literature survey will be performed to assess the state-of-the-art.
Preliminary Design
A preliminary design will be completed by the eighth week of class and submitted to the instructor as a report from each group.
Final Design
The final design including all drawings and specifications will be completed by the end of the Fall semester and submitted to the instructor as a report from each group. The report will include all parts and budget.

Fabrication and Testing
Fabrication and testing will be performed during the Spring semester. All tasks will be completed by the end of the twelfth week.

Final Report
The final report from each group will be due during the last week of class.

Tasks
The following tasks will be performed: 1) design of test stand including Graphical User Interface, 2) CAD model of test stand, 3) fabrication and validation of test stand, 4) maintain up-to-date budget within the limit set by the Department, 5) maintain Sakai website with all results.

Meetings
There will be weekly meetings with the instructor. For each group, one member will make a 15 min Power-Point presentation including the following information: 1) Tasks accomplished during the previous week, 2) Tasks assigned for the next week (each person named), 3) Technical challenges and questions.

The presenter for each group will rotate among the entire group.

Professor Knight  K2 650:487

Design of Model Rocket Engine Thrust Stand
Groups K1 and K2

Introduction and Eligibility
There will be two groups (K1 and K2) with a maximum of five students per group. Groups K1 and K2 are open to Aerospace Engineering majors only.

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**Professor Lee L1**

3D Printing with Novel Materials

**Project Description:** 3D printing refers to techniques to create three-dimensional (3D) physical objects directly from computer-aided-design (CAD) models by joining materials in a layer-by-layer fashion. A wide variety of materials have been used for 3D printing, including polymers, metals, ceramics, and composites. In this project, we aim to develop a new 3D printer and process, with which one can print non-traditional materials. Examples may include chocolate, cookie dough, recycled material from plastic bottles, and many others. This is a great opportunity for students who seek for hands-on experience in mechanical design, instrumentation, and programming. The project involves (1) design and machining of mechanical components (40%), (2) programming for automation and process planning (30%), and (3) characterizing material properties of printing materials (30%).

**Prerequisites:** Familiarity with instrumentation and microcontroller programing (Labview, Arduino, Python, or other similar platform that drives motors/stages from PC), CAD software (AutoCAD, SolidWorks, etc), basic machining skill, basic understanding of material behavior.

**Professor Lee L2**

Continuous 3D Printing with Moving Platform

**Project Description:** 3D printing refers to techniques to create three-dimensional (3D) physical objects directly from computer-aided-design (CAD) models by joining materials in a layer-by-layer fashion. Despite the freedom to manufacture highly complex objects, most 3D printers can print one object at a time. Inspired by mechanism of digital data storage devices such as CD and HDD where extremely large amount of digital data is rapidly written and accessed, we will develop a new 3D printer capable of printing multiple objects rapidly and continuously on a rotating platform. This is a great opportunity for students who seek for hands-on experience in mechanical design, instrumentation, and programming. The project involves (1) design and machining of mechanical components (40%), (2) programming for automation and process planning (40%), (3) characterizing rheological properties of polymer resin (20%).

**Prerequisites:** Familiarity with instrumentation and microcontroller programing (Labview, Arduino, Python, or other similar platform that drives motors/stages from PC), CAD software (AutoCAD, SolidWorks, etc), basic machining skill, basic understanding of material behavior.
Description: As we start to venture into space again, there is a need to develop technologies for rapid fabrication of housing using resources that are available on planets (e.g., sand and rock). This project will develop a 3D printer that is capable of building solid structures (on a small scale) based on a binder-jet type system but using sand as a base material.

Learning Opportunity: This is a great opportunity for students who seek experience with advanced additive manufacturing techniques. The project involves (1) Design and integration of mechanical components (50%) (2) Control integration for automation of the process (50%)

Desired qualities: Some familiarity with 3D printing and controller instrumentation programming (Labview, Arduino, or other similar platform that drives motors/stages from PC), CAD software (AutoCAD, SolidWorks, or others), basic machining skills.

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**Professor Norris N1**
Problem Statement: To design, fabricate and test a dynamic vibration absorber rig that can be used by MAE students to demonstrate vibration control theory for minimizing machine vibration. The final product will include a controllable variable-speed drive, an unbalanced rotating disc, compressive springs, and an adjustable mass. The rig should be robust and able to operate with large vibration amplitude without wear. Design and testing will identify the most likely source of failure, and will come up with strategies for operational improvement. A basic but instructive example of a dynamic vibration absorber rig is [http://bit.do/443_4](http://bit.do/443_4).

**Professor Norris N2**
Problem Statement: To design, fabricate and test a dynamic vibration absorber rig that can be used by MAE students to demonstrate vibration control theory for minimizing machine vibration. The final product will include a controllable variable-speed drive, an unbalanced rotating disc, compressive springs, and an adjustable mass. The rig should be robust and able to operate with large vibration amplitude without wear. Design and testing will identify the most likely source of failure, and will come up with strategies for operational improvement. A basic but instructive example of a dynamic vibration absorber rig is [http://bit.do/443_4](http://bit.do/443_4).

**Professor Pelegri P1**

Design of a Humane Squirrel Repelling Water Gun Robot

The cute squirrels that live in the trees and play on our lawns love to dig our flower pots. During this project a robot equipped with a water gun and machine vision will be designed and prototyped. The specific goals of this project entail: 1) design a robot to shoot bursts of water at a squirrel at a distance of 20 ft, 2) enable robotic vision covering a wide angle, 3) enable recognition of a squirrel within 5 sec, 4) enable rotation of the robot about two axis, and 5) fabricate and successfully test the above mentioned system.

**Professor Pelegri P2**

DROP TOWER IMPACT TESTING SYSTEM

**Professor Shan S1**

**Professor Shan S2**
High-Power Spatial Light Modulator

The team will be tasked with building a spatial light modulator capable of manipulating high-power lasers through the use of hybrid lithographic patterning. This will involve assembly of the optical system, simulation of its operation, and demonstration of the technology for later scaling into a complete system.

Roll-to-Roll Electrospray Deposition

Team will be tasked with building a roll-to-roll apparatus to continuously deposit thin films onto a non-conductive substrate. Compared to other modes of spray, electrospray deposition can produce highly uniform films due to the electrostatically driven production of monodisperse nano/microdroplets; however, the electrostatic nature of the process leads to issues with non-conductive substrates. A successful project will incorporate strategies to mitigate repulsion issues and simultaneously allow for substrate heating for post-treatment and homogenization of the films. Early stages of the project will focus on the design of a system that incorporates these features, while later stages will involve construction and testing the resulting deposition system.

High Strength, Light Weight Cylindrical Pressure Vessel with Fiber-Reinforced Composites

Project Description:
For space applications or other environments where both light weight and high strength are essential factors for consideration, fiber-reinforced polymer composites often provide one of the best choices as compared to traditional materials such as steel or aluminum. In this project, we will first learn the basic principles of fiber reinforced composites, and then apply them to construct a cylindrical pressure vessel subjected to a prescribed internal pressure. For optimal
design, an in-plane orthotropic laminated construction needs to be sought for. Through analysis based on the stiffness and strength of fibers and polymer matrix, an optimal design will be developed. Based on this conceptual design, we will then proceed to build the pressure vessel with multi-layered cross-ply configuration. The critical design factors are to build the strongest and largest possible vessel within the allocated budget so that it can contain the maximum amount of substance under high pressure without burst. The developed pressure vessel will be tested, and its functions will be compared with those of stainless steel.

**Professor Weng W2**

W2: High Strength, Light Weight Spherical Pressure Vessel with Fiber-Reinforced Composites

Project Description:
- For space applications or other environments where both light weight and high strength are essential factors for consideration, fiber-reinforced polymer composites often provide one of the best choices as compared to traditional materials such as steel or aluminum. In this project, we will first learn the basic principles of fiber reinforced composites, and then apply them to construct a spherical pressure vessel subjected to a prescribed internal pressure. For optimal design, an in-plane isotropic laminated construction needs to be sought for. Through analysis based on the stiffness and strength of fibers and polymer matrix, an optimal design will be developed. Based on this conceptual design, we will then proceed to build the pressure vessel with multi-layered isotropic configuration. The critical design factors are to build the strongest and largest possible vessel within the allocated budget so that it can contain the maximum amount of substance under high pressure without burst. The developed pressure vessel will be tested, and its functions will be compared with those of stainless steel.

**Professor Yi Y1**

**Professor Yi Y2**

**Professor Zou Z3**

**Professor Zou Z4**