2017-18 Senior Design projects

Professor Bagchi B1-B2

Biomematic flying and swimming (2 teams)

Description: The project aims to develop robotic/mechanical bird and/or fish

Professor Bai B5-B6

Professor Baruh B3

Motorization of a Conventional Wheelchair

This project will build on a successful design project (2015-2016 academic year) to develop a conversion kit to convert a traditional wheelchair to a motorized one. The idea is to create a kit that can be installed on a wheelchair in less than two hours. It should also be possible to remove the motorization kit in an hour and to return the wheelchair to its original state. To this end, optimization of the motor size and battery capacity is required. The smoothness of the ride of the wheelchair is a very important factor. Also, while the motorization kit is installed, the rider should be able to ride the wheelchair in motorized as well as in human-powered form. The conversion kit has to be as lightweight as possible.

Professor Baruh B4

Aircraft Conflict Resolution Cataloger

This project will be conducted in collaboration with the Federal Aviation Administration. The end product of this project will be the development of a software tool to help identify and catalogue the conflict resolution events that occur in the National Aerospace System at altitudes over 18,000 ft by matching the predicted alerts and trajectories with evidence of physical maneuvers and recorded clearances (i.e. recordings of air traffic control communications to the aircraft) that result in the removal of the alert and changes to the predicted trajectory. The development of the software tool will require some dynamics simulations as well. Please note: Substantial experience with Matlab programming is required to implement this project. Also, because the project will involve frequent trips to the FAA, U.S. citizenship is required to facilitate the entry into the FAA buildings.

Professor Benaroya B7

Inflatable-Deployable Structures for the Lunar Surface:

Concepts will be developed and designed, addressing the environmental issues we find on the lunar surface. In addition to the environmental issues, there are the structural fabrication, deployment, and rigidizing the inflatable part of the structure.

Professor Benaroya B1 650:487 Aerospace students

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Professor Bottega B9-BW

Wind Walkers

The section will be divided in to 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 Callegari C1-C2

Professor Cuitino C3

Design for Manufacturing Bench Press Neck Guard

A recent patent (https://www.google.com/patents/US20150011367) has been granted to Mr. Andrew Schmidt for Bench Press Neck Guard. This is "a portable lifesaving device that prevents a falling weight bar from injuring the neck while a weightlifter performs a bench press...". Mr. Smith has developed the first prototype but there is the opportunity to introduce engineering concepts to concurrently explore shape and material options towards a simple, robust and economical product. The goals of this project are: to develop a conceptual design plan based on the current patent, to manufacture prototypes, to assess safety through testing and to evaluate cost options. The tasks of these project include conceptualization and design, numerical simulations, manufacturing, testing, communication (weekly meetings/presentations/reports). The deliverables are 1) periodic technical reports, 2) working prototype, 3) safety assessment study, 4) general audience material (presentation, video, brochures). This opportunity is open to students with strong interest towards bringing a product to market.

Professor DeMauro D7

Two groups will compete against each other in the design of an aircraft capable of flying up to a pound of payload into the air and landing. The aircraft must be lightweight and cost efficient. Design considerations for the aircraft include its aerodynamics, stability and control, structure, and the ability to complete a required mission. 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:

1. Fixed-wing
a. No delta wing or sweep
b. May be tapered
c. The fuselage may be as thin as desired
d. Single engine propeller
2. Only the vertical and horizontal tails may be symmetric airfoils
a. You have the option to have a canard, but keep in mind that it may be trickier!
b. Provide justification for the selection of the wing airfoil shape
3. Ability to carry up to 1 lb of candy
4. Ability to drop the payload when in the air
5. Take-off and land under its own power
6. Can perform a coordinated turn
7. The wingspan of the aircraft cannot be larger than 3 feet

Therefore, the mission profile for each plane includes taxi, takeoff, climb, cruise, drop payload, descent, and landing, with at least one banked turn. Each plane will be judged based on how they meet the criteria, how their planes perform compared to each other (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. Use of programs like XFoil is encouraged.

Professor DeMauro D1   650:487 Aerospace students

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Professor Denda D1-D2

Bio-Inspired Flapping Wing Energy Harvester (2 groups)

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 that 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 Diez D3

Design and Fabrication of a multirotor or a fix wing small unmanned air vehicle capable of performing one of the following three missions. (1) Increase fly endurance for long term missions up to 24 hrs by using solar cells; (2) Collocate propellers in such a fashion to imitate a hover bike (if scaled up this could carry a person similar to the Star Wars hover bike); (3) add a vertical wing to a multirotor for increase endurance and range.

Professor Diez D2 650:487 Aerospace students

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Professor Drazer D5-D6

Professor Guo G3-G4

Device Design for Harvesting Thermal/Solar Energy

You have a few options for choice in your device design. For example, you may consider harvesting solar energy via a smart window, or creating a thermoelectric power generator, or any other forms of energy conversion. The thermoelectric effect is an interchange between temperature differences and electric voltage. A thermoelectric device creates voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. The objective of this project is to design, build, and analyze a device for thermal or solar power generator with practical applications.

Professor Jaluria J1

Wind Energy System

Design of a system to demonstrate the use of wind energy to pump water. The system consists of the wind turbine, energy storage and arrangement to pump water to a given height. The wind may be simulated by means of an electric fan. The system is to be designed, optimized, fabricated and tested.

Professor Jaluria J2

Cooling System for Electronic Equipment

A cooling system for heat removal from electronic systems, such as Data Centers, is to be designed and fabricated to achieve temperature control of the devices. For a given high level of heat flux input, the fluid, geometry, and the cooling arrangement are to be designed. The requirements on maximum temperature and uniformity in the devices are to be met, within the space and cost constraints

Professor Knight K1-K2 650:487 Aerospace students

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. The groups 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 Lee L1

Developing a Food 3D Printer

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 compact, affordable, and sanitary food 3D printer, which will allow one to print food in creative shapes and colors to add value and joy for special occasions. Multiple nozzles will be integrated to be able to inject multiple ingredients such as cookie dough, bread paste, and chocolate.

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 various food ingredients (10%), and (4) cooking (10%)

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 on a Rotating 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.

Professor Lin L3-L4

Design of an on-stage, micro-climated controlled cell incubabor

We will design and implement a micro-climate (temperature, humidity, CO2, etc) controlled incubator for cell culturing, incubation, and observation on a microscope stage. The heating power will be supplied by electricity. The control will be realized via feed-back electronic circuits and algorithms. The incubator housing will be rapid-prototyped.

Professor Liu L5-L6

Professor Mazzeo M1-M2

Professor Muller M3-M4

Professor Mahorta M5-M6

Professor Norris N1-N2

CBF: Cheaper, Better Faster. Adapting inexpensive devices and optimized computational codes to develop cheaper, better and faster mechanical measurements.

The development of Matlab, Comsol, and other software packages allows the same type of digital analysis on a laptop that used to be (10 to 20 years ago) reserved for very expensive analog equipment. At the same time, manufacturing
has dramatically reduced the price of measurement devices. The team project will brainstorm to develop new uses of this unused computational and measurement potential. Vibration characterization will be the initial focus: The group will adapt cheap (approx. 2$) but versatile accelerometers to measure dynamic properties of materials and structures, and write GUIs to communicate the data.

Recommended: Some knowledge and appreciation for vibration, dynamics, and Matlab.

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 Shan S1

Title: Pond Cleanup

Design a floating, amphibious, or flying craft to clean up floating debris like milk jugs from a pond, and deposit the cargo on land (ideally in a trash can).

Professor Shan S2

Title: Pond Cleanup

Design a floating, amphibious, or flying craft to clean up floating debris like milk jugs from a pond, and deposit the cargo on land (ideally in a trash can).

Professor Shojaei-Zadeh S3-S4

Professor Singer S-5

Metamaterials for Photothermal Microwave Heating

Team will be tasked to demonstrate targeted heating of metamaterial resonators using household microwave sources (*e.g.* oven magnetron) with an aim to create localized convective flows. This will require optimization of geometry and materials to maximize thermal conversion while keeping the targeted resonance. Team will incorporate infrared thermometry to assess the efficacy of their designs. Early stages of the project will involve finite elements simulations of the target structures while building the imaging setup. Later stages of the project will involve the fabrication and testing of the metamaterial structures.

Professor Singer S-6

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 simultaneonsly 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.

Professor Scacchioli S7-S8

Professor Weng W1

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

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

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

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-Y2

Autonomous robotic grinder

Description: The team is asked to design, fabricate and test an autonomous robotic grinder for civil infrastructure applications. The robotic grinder should be operated autonomously or remotely controlled by human operators to grind any concrete surface in buildings, bridge decks or parking lots, etc. The team will work on both the mechanical, electrical and computer systems design of the robotic grinder.

Professor Zou Z3

Professor Zou Z4