Rutgers University

Department of Mechanical & Aerospace Engineering

2022-2023 Senior Design Projects

14:650:487/488 Aerospace Engineering Design I/II

Aerospace Engineering Projects

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AE PROJECT 1

Mechanical Bird

Advisor: Prof. Prosenjit Bagchi

Email: pbagchi@soe.rutgers.edu

Project Abstract: Building mechanical bird

Project Goals: Design and fabrication of a device that can fly like a bird

Project Envisioned Outcomes: Generation of aerodynamic thrust and lift using flapping wings.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design		☑			
Analysis		☑			
Hand tools		☑			
Traditional Machining		☑			
CNC machining	☑				
3D printing		☑			
Welding		☑			
Wiring		☑			
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)		☑			
Microcontrollers (e.g., Arduino)		☑			
Bonding	☑				
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol			☑		
Python	☑				
Ansys	☑				
SolidWorks			☑		
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 2

Airplane Stability and Control Derivatives

Advisor: Prof. Haim Baruh

Email: baruh@soe.rutgers.edu

Project Abstract: Design of Airplane stability and control derivatives.

Project Goals: To build an aircraft whose stability and control derivatives are within desired ranges

Project Envisioned Outcomes: Construction of a plane

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis			☑		
Hand tools				☑	
Traditional Machining			☑		
CNC machining			☑		
3D printing	☑				
Welding			☑		
Wiring				☑	
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)			☑		
Bonding			☑		
Processing (e.g., vacuum bag, autoclave)			☑		

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol			☑		
Python			☑		
Ansys			☑		
SolidWorks			☑		
Other CAD packages			☑		
Siemens NX		☑			
LabView			☑		
E-Calc		☑			
AVL		☑			
Xfoil		☑			
Machine vision program		☑			

AE PROJECT 3

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

Advisor: Prof. Onur Bilgen

Email: o.bilgen@rutgers.edu

Project Goals: 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.

Previous Success: The 2020 team received a research award from the highly competitive NASA USRC program. (https://mae.rutgers.edu/news/senior-design-team-captures-nasa-research-challenge).The new team will apply to the same program in June. In addition, the 2020 Team presented a paper at the AIAA 2021 Region I Conference, and received the 3rd place prize in the team category.

All team members are expected to have an exceptional work ethic and dedication to the project. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email (o.bilgen@rutgers.edu) with the subject line starting with "Senior Design: Project Name – Your Name".

Project Envisioned Outcomes: See above.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis				☑	
Hand tools				☑	
Traditional Machining				☑	
CNC machining	☑				
3D printing		☑			
Welding	☑				
Wiring				☑	
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)				☑	
Bonding	☑				
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol				☑	
Python				☑	
Ansys				☑	
SolidWorks				☑	
Other CAD packages				☑	
Siemens NX		☑			
LabView	☑				
E-Calc				☑	
AVL				☑	
Xfoil				☑	
Machine vision program				☑	

Additional Requirements and Information:

Please send an email to Dr. Bilgen (o.bilgen@rutgers.edu) with the subject line starting with "Senior Design: " and include the following content:

1) A brief statement indicating interest

2) Project(s) of interest (primary and secondary can be indicated)

3) Cumulative GPA (in major)

4) Theoretical (subject) strengths (i.e. dynamics, solids, fluids, control, design, etc.)

5) Software strengths

6) Hands-on, fabrication, testing strengths and experiences (outside of courses and labs)

7) Student organizations involved

AE PROJECT 4

Drone Based Water Sampling and Quality Testing – Special Application in the Raritan River

Advisor: Prof. Onur Bilgen

Email: o.bilgen@rutgers.edu

Project Goals: The goal of this project is the design, analysis, fabrication and testing of an unmanned aerial vehicle (UAV) and a ground station, both equipped with 5G transmitters/receivers to evaluate water quality in rivers and other waterways. The system will be tested in the Raritan River. The team will design, fabricate and test multiple iterations of the vehicle, and the ground station, as well as develop necessary control algorithms. The drone will sample water (from the water surface and/or at varying depths in the water column) and bring it back to a testing station near the shore (or within the range of the drone.) This system must be fully autonomous.

This is a collaborative project with Professor Nicole Fahrenfeld of the Civil & Environmental Engineering. Using the drone will significantly increase spatial resolution of sampling while providing improved ability to provide composite samples for analysis. The anticipated outcome will be reducing labor/need for sampling vessels to while generating more representative samples to improve our understanding of contaminant fate and transport in surface waters. Example target contaminants include emerging (e.g., microplastics) or regulated (e.g., pathogens linked to compliance with Section 303d of the Clean Water Act).

The students should be very comfortable with at least one of the following: 1) Design/analysis and programming software such as Matlab, Xfoil, AVL, E-Calc, Mission Planner, 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, Raspberry Pi), wiring, soldering, 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 from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email (o.bilgen@rutgers.edu).

Project Envisioned Outcomes: See above.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis				☑	
Hand tools			☑		
Traditional Machining			☑		
CNC machining				☑	
3D printing				☑	
Welding				☑	
Wiring				☑	
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)				☑	
Bonding	☑				
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol	☑				
Python			☑		
Ansys	☑				
SolidWorks				☑	
Other CAD packages				☑	
Siemens NX		☑			
LabView		☑			
E-Calc				☑	
AVL		☑			
Xfoil		☑			
Machine vision program		☑			

Additional Requirements and Information:

Please send an email to Dr. Bilgen (o.bilgen@rutgers.edu) with the subject line starting with "Senior Design: " and include the following content:

1) A brief statement indicating interest

2) Project(s) of interest (primary and secondary can be indicated)

3) Cumulative GPA (in major)

4) Theoretical (subject) strengths (i.e. dynamics, solids, fluids, control, design, etc.)

5) Software strengths

6) Hands-on, fabrication, testing strengths and experiences (outside of courses and labs)

7) Student organizations involved

AE PROJECT 5

Small Scale Reusable Launcher

Advisor: Prof. Laurent Burlion

Email: laurent.burlion@rutgers.edu

Project Abstract: The group of students will design and test a small scale reusable launcher that uses vision and propellers to precisely land on a given point.

Project Goals: Combine a traditional hovering quadcopter with a rocket to get a small-scale reusable launcher.

Project Envisioned Outcomes: Build and test a reusable small scale launcher that can land precisely on a given point .

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis				☑	
Hand tools			☑		
Traditional Machining			☑		
CNC machining		☑			
3D printing			☑		
Welding			☑		
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)				☑	
Bonding	☑				
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol	☑				
Python				☑	
Ansys			☑		
SolidWorks				☑	
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc			☑		
AVL	☑				
Xfoil	☑				
Machine vision program			☑		

AE PROJECT 6

NASA University Student Research Challenge

Advisor: Prof. Edward DeMauro

Email: ed451@soe.rutgers.edu

Project Abstract: University Student Research Challenge (solicitation NNH20ZEA001N-USRC) seeks to challenge students to propose new aeronautics ideas/concepts that are relevant to NASA Aeronautics. USRC will provide students, from accredited U.S. colleges or universities, with grants for their projects and it includes the challenge of raising a modest amount of cost share funds through crowdfunding platform. The process of creating and preparing a crowdfunding campaign acts as a teaching accelerator - requiring students to act like entrepreneurs and taking action. Crowdfunding also raises awareness about students' research among the public. The solicitation goal can be accomplished through project ideas such as advancing the design, developing technology or capabilities in support of aviation, by demonstrating a novel concept, or enabling advancement of aeronautics-related technologies. Notices of Intent (NOIs) are not required for this solicitation. Three-page proposals for the next USRC cycle are due June 24, 2021.

Project Goals:

(1) Submission of a proposal according to NASA's requirements (June 24, 2021)

(2) Identification of an engineering solution to commercial supersonic air travel, tackling issues associated with sonic boom generation

(3) Proof of concept through theoretical, empirical, and/or computational means

(4) Assessment of current competing technologies and how our concept compares

Project Envisioned Outcomes: I envision that the team will produce a detailed engineering design assessment, proven using theoretical, empirical, and/or computational tools, detailing a planned methodology for manipulating the sonic boom on a supersonic aircraft. This is a NASA proposal, which means that there is a great deal of work to be accomplished by June 24th. Therefore, I will need students ready to start ASAP.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis			☑		
Hand tools			☑		
Traditional Machining				☑	
CNC machining				☑	
3D printing			☑		
Welding		☑			
Wiring					☑
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)		☑			
Bonding	☑				
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol			☑		
Python		☑			
Ansys			☑		
SolidWorks			☑		
Other CAD packages			☑		
Siemens NX			☑		
LabView			☑		
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

Additional Requirements and Information:

https://nspires.nasaprs.com/external/viewrepositorydocument/cmdocumentid=813834/solicitationId=%7BC9CC1B80-9F50-7B37-2A9B-33CC623FA556%7D/viewSolicitationDocument=1/3.%20ROA-2020%20ULI%20Amendment%203%20Final_108p.pdf

AE PROJECT 7

Persistent Drone Weather Monitoring

Advisor: Prof. F. Javier Diez

Email: diez@soe.rutgers.edu

Project Abstract: Persistent drone weather monitoring

Project Goals: Develop a drone that can flight tethered continuously for 24hrs for weather monitoring

Project Envisioned Outcomes: Demo a drone that can achieve the project goals.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis		☑			
Hand tools			☑		
Traditional Machining		☑			
CNC machining		☑			
3D printing		☑			
Welding		☑			
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)				☑	
Bonding		☑			
Processing (e.g., vacuum bag, autoclave)		☑			

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol		☑			
Python				☑	
Ansys		☑			
SolidWorks			☑		
Other CAD packages			☑		
Siemens NX		☑			
LabView			☑		
E-Calc			☑		
AVL		☑			
Xfoil			☑		
Machine vision program			☑		

AE PROJECT 8

Design of Model Aircraft Electric Engine Thrust Stand

Advisor: Prof. Doyle Knight

Email: ddknight@rutgers.edu

Project Abstract: The project is the design, fabrication and demonstration of Design and fabricate model aircraft electric engine thrust stand

Project Goals: Design and fabricate model aircraft electric engine thrust stand

Project Envisioned Outcomes: Model aircraft electric engine thrust stand

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design		☑			
Analysis			☑		
Hand tools			☑		
Traditional Machining			☑		
CNC machining		☑			
3D printing				☑	
Welding			☑		
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)				☑	
Bonding			☑		
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol			☑		
Python		☑			
Ansys			☑		
SolidWorks				☑	
Other CAD packages			☑		
Siemens NX	☑				
LabView				☑	
E-Calc			☑		
AVL	☑				
Xfoil			☑		
Machine vision program	☑				

AE PROJECT 9

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

Advisor: Prof. George Weng

Email: gjweng@rutgers.edu

Project Abstract: Use carbon fibers and epoxy resin to make polymer composites, and use the composites to build a spherical pressure vessel.

Project Goals: To build a light-weight composite spherical pressure vessel that can sustain high pressure without failure.

Project Envisioned Outcomes: A hardware composite spherical pressure vessel.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design		☑			
Analysis		☑			
Hand tools		☑			
Traditional Machining		☑			
CNC machining		☑			
3D printing		☑			
Welding		☑			
Wiring		☑			
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)		☑			
Microcontrollers (e.g., Arduino)		☑			
Bonding			☑		
Processing (e.g., vacuum bag, autoclave)			☑		

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python	☑				
Ansys	☑				
SolidWorks	☑				
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 10

A Multi-dimensional Fleet of Intelligent Mobile Plants for Unknown Territory Exploration

Advisor: Prof. Qingze Zou

Email: qzzou@rutgers.edu

Project Abstract: In this project, we are creating a fleet of mobile plants combining both ground robots and drones working cooperatively together to seek resources and maximize the plants survivability in an unknown and potentially hazardous territory. The idea is to equip the plants with mobility, environment sensing (e.g., light, temperature, and vision) and communication capability (wireless communication), and allow and help the plants to communicate and share information with each other about the environment, to seek resources (e.g., water, light) and/or avoid dangers (e.g., harsh temperature and/or harmful insects), thereby, turning the group of plants into a group of social "animal-like" subjects. This project is built upon the success of IndaPlant senior design projects and plant-centered mobile robot network in the last a few years. The task of your team is to further enhance the function and capability of three mobile robots, develop autonomously-flying drones, and make the robots and drones working together in real-time for territory exploration.

Project Goals: Creating a fleet of mobile plants combining both ground robots and drones working cooperatively together to seek resources and maximize the plants survivability in an unknown and potentially hazardous territory.

Project Envisioned Outcomes: Enhance the function and capability of the robot network, develop autonomously-flying drones, and make the robots and drones working together in real-time for territory exploration.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design		☑			
Analysis	☑				
Hand tools		☑			
Traditional Machining	☑				
CNC machining	☑				
3D printing	☑				
Welding	☑				
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)			☑		
Bonding		☑			
Processing (e.g., vacuum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python	☑				
Ansys	☑				
SolidWorks	☑				
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program			☑		

Additional Requirements and Information:

Programming experience with Arduino and Raspberry Pi