Rutgers University

Department of Mechanical & Aerospace Engineering

2024-2025 Senior Design Projects

14:650:467/468 Design and Manufacturing I/II

Mechanical Engineering Projects

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ME PROJECT 1

Electrically Propelled Watercraft

Advisor: Prof. Prosenjit Bagchi

Email: pbagchi@soe.rutgers.edu

Project Goals: Design, build, and test a small watercraft to compete in the American Society of Naval Engineers 2024-2025 Promoting Electric Propulsion competition, which includes a 5-mile endurance race against other scholastic teams. Design must be fully electric powered, i.e. not have any internal combustion engine, sails, or be charged from an onboard generator, solar or other renewable charging is allowed. Vessel must also be in compliance with the A.S.N.E. 2024-2025 Promoting Electric Propulsion rulebook.

Project Envisioned Outcomes: Design and fabrication of a sustainable electric marine 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					

ME PROJECT 2

Mechanical Fish

Advisor: Prof. Prosenjit Bagchi

Email: pbagchi@soe.rutgers.edu

Project Goals: Conceptualize, design, fabricate and demonstrate a mechanical device that can swim and maneuver like a fish using body undulations.

Project Envisioned Outcomes: robot fish

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					

ME PROJECT 3

Kayak Paddle Design for Disabled People

Advisor: Prof. Haim Baruh

Email: baruh@soe.rutgers.edu

Project Goals: Design and build a paddle attachment or a paddle that would allow a user to successfully

Project Envisioned Outcomes: A paddle or paddle attachment

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://bendingbranches.com/blogs/resources/adaptive-kayaking-and-canoeing-get-more-people-on-the-water

ME PROJECT 4

RU Power – Rutgers Marine Energy Collegiate Competition Team (2024-2025)

Advisor: Prof. Onur Bilgen

Email: o.bilgen@rutgers.edu

Please contact Dr. Bilgen via email with the subject line starting with "Senior Design: Project Name – Your Name".

Project Goals: The goal of this project is the design, analysis, fabrication and testing of a small (model-scale) hydrokinetic turbine prototype for the purpose of competing in the Department of Energy (DOE) Marine Energy Collegiate Competition (MECC) which will take place in May 2025. The team will design, fabricate, and test multiple iterations of the hydrokinetic turbine, as well as develop necessary control algorithms. News releases from the previous teams can be found on the SOE Website: 2024 Team.

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) with the subject line starting with "Senior Design: RU Power – <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:

Application Process:

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

ME PROJECT 5

RU Wind – Rutgers Collegiate Wind Competition Team (2024-2025)

Advisor: Prof. Onur Bilgen

Email: o.bilgen@rutgers.edu

Project Goals:

The goal of this project is the design, analysis, fabrication and testing of a small (model-scale) offshore wind turbine prototype for the purpose of competing in the Department of Energy (DOE) Collegiate Wind Competition (CWC) which will take place in May 2025. The team will design, fabricate, and test multiple iterations of the turbine, as well as develop necessary control algorithms. News releases from the previous teams can be found on the SOE Website: 2023 Team and 2024 Team.

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) with the subject line starting with "Senior Design: RU Wind – <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

ME PROJECT 6

Remote Control Lawn Mower and Trimmer

Advisor: Prof. Kimberly Cook-Chennault

Email: cookchen@soe.rutgers.edu

Project Goals: Produce a portable remote control grass mower and trimmer that can be power by a hybrid power system.

Project Envisioned Outcomes: Students will learn the engineering design process and produce a functional grass cutter and trimmer that can be control by the user remotely without having to push it.

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://www.husqvarna.com/us/robotic-lawn-mowers/?gad_source=2&gclid=CjwKCAjww_iwBhApEiwAuG6ccDrznDbn2hs8TH53_LCtSszaoyFoJOozjpsVb-aa2Ki-GABbIskfdRoCFU4QAvD_BwE&gclsrc=aw.ds

ME PROJECT 7

Bio-Inspired Flapping Wing Energy Harvester I

Advisor: Prof. Mitsunori Denda

Email: denda@rutgers.edu

Project Goals: 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.

Project Envisioned Outcomes: Team members will design and construct their own wind energy harvester, then test its performance under different conditions.

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	☑				

ME PROJECT 8

Bio-Inspired Flapping Wing Energy Harvester II

Advisor: Prof. Mitsunori Denda

Email: denda@rutgers.edu

Project Goals: 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.

Project Envisioned Outcomes: The students 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.

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	☑				

ME PROJECT 9

Liquid-Based Portable Filtration Device to Improve Indoor Air Quality During Smoke Events

Advisor: Prof. German Drazer

Email: german.drazer@rutgers.edu

Project Goals: The overall goal is to design an efficient air particulate filtration system. The system should be able to significantly reduce particulate matter concentration (e. g. 80% reduction PM2.5) in a short time (e. g. 1 hour) in a typical room (e. g. 150 square feet, 8 foot-ceiling) and maintain it for prolonged periods of time (e. g. days to weeks).

Project Envisioned Outcomes: Creating a novel air filtration device for particulate matter

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://www.youtube.com/watch?v=qDVcZ_scUss

ME PROJECT 10

Automated Gantry System for Individualized Products

Advisor: Prof. Xi Gu

Email: xg107@soe.rutgers.edu

Project Goals: The objective of this project is to design and construct a fully automated and flexible gantry system for individualized manufacturing/assembly. The system should be capable of picking, moving, and placing different items requested by individual users (by controlling the speed of movement, etc.) The students will have the flexibility to formulate the design problem with specified applications.

Project Envisioned Outcomes: A built gantry system with control.

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	☑				

ME PROJECT 11

Solar Utilization as a Renewable and Green Energy

Advisor: Prof. Zhixiong Guo

Email: zguo@rutgers.edu

Project Goals: The objective of this project is to have a comprehensive understanding of knowledge learned in college and convert them into designing, building, and analyzing a solar power driven device.

Project Envisioned Outcomes: Design, analysis, fabrication, test

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	☑				

ME PROJECT 12

3D Printing Quality Monitoring and Control System

Advisor: Prof. Yuebin Guo

Email: yuebin.guo@rutgers.edu

Project Goals: Get hands-on experience on sensing-learning-and control loop in 3D printing

Project Envisioned Outcomes: Working knowledge on sensing-learning-and control loop in 3D printing

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			☑		

ME PROJECT 13

3D Printing Customized Knee Implant

Advisor: Prof. Yuebin Guo

Email: yuebin.guo@rutgers.edu

Project Goals: Design, 3D print, and simulate of Customized Knee Implant

Project Envisioned Outcomes: A prototype of customized knee implant

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		☑			

ME PROJECT 14

Wind Energy System Plus Energy Storage

Advisor: Prof. Yogesh Jaluria

Email: jaluria@soe.rutgers.edu

Project Goals: Design of a system to demonstrate the use of wind energy to pump water and store energy. The system consists of the wind turbine, energy storage and arrangement to pump water for distribution or to a given height.

Project Envisioned Outcomes: A windy day may be used to test the system, or the wind may be simulated by means of an electric fan. The system is to be designed, optimized, fabricated, and tested.

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					

ME PROJECT 15

Concentrated Solar Energy System

Advisor: Prof. Yogesh Jaluria

Email: jaluria@soe.rutgers.edu

Project Goals: Design and fabricate a concentrated solar energy system, with tracking of the Sun, to heat water, which may be used for thermal processing, desalination, or heating.

Project Envisioned Outcomes: Concentrated solar energy system including an energy storage system to take care of night-time and other durations when solar energy is not available.

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	☑				

ME PROJECT 16

Design, Fabrication and Testing of Test Stand to Measure Torque and Power of RC Electric Motors

Advisor: Prof. Doyle Knight

Email: ddknight@rutgers.edu

Project Goals: Develop test stand to measure torque and power of RC electric motor

Project Envisioned Outcomes: Successful design, fabrication and testing of test 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	☑				

ME PROJECT 17

3D Printer Capable of Printing Elastomeric Composites

Advisor: Prof. Jennifer Lynch-Branzoi

Email: jklynch@soe.rutgers.edu

Project Abstract: 3D printing is used to quickly fabricate prototypes. With the development of new materials, including polymeric nanocomposites, 3D printing is a good choice to easily fabricate parts from these novel feedstocks and perform materials characterization. However, high concentration of nanoparticles in a polymer matrix nanocomposite can cause difficulties when using a 3D printer. The aims of this project are to develop and build a 3D printer capable of printing elastomeric composites with a high concentration of nanoparticles and characterize printed novel elastomeric composites, as well as the elastomer alone as a control.

Project Goals: The project goals are to (1) develop and build a 3D printer capable of printing elastomeric composites with a high concentration of nanoparticles, (2) enable accessories to be used with the printer including a spot heater to aid curing and a thermal imager to monitor curing, and (3) characterize these printed novel elastomeric composites, as well as the elastomer alone as a control.

Project Envisioned Outcomes: The primary outcome of this project will be a functioning 3D printer enabling printing of novel polymeric nanocomposites with in situ monitoring of the curing process, which will aid in materials optimization for a specific application and prototyping.

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:

Use Excel or Origin for data analysis

A similar project can be found at http://3dprintingfromscratch.com/common/how-to-build-a-3d-printer-from-scratch/

ME PROJECT 18

3D Printer for Thermoplastics, Thermosets, Conductive and Metallic Materials

Advisor: Prof. Rajiv Malhotra

Email: rajiv.malhotra@rutgers.edu

Project Abstract: The project involves the integration of lasers and other light sources with an in-development 3D printer for printing thermoplastics, thermosets, conductive and metallic materials within the same process. A setup has been developed in past projects for this process. This particular project will involve integration of a fiber-laser with this setup to enable laser processing of these materials as well.

Project Goals: The project involves the integration of lasers and other light sources with an in-development 3D printer for printing thermoplastics, thermosets, conductive and metallic materials within the same process.

Project Envisioned Outcomes: Integration of lasers and other light sources with an in-development 3D printer for printing thermoplastics, thermosets, conductive and metallic materials within the same process.

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					

ME PROJECT 19

Detachable Propulsion Unit for Surfboards of Varying Size I

Advisor: Prof. Aaron Mazzeo

Email: aaron.mazzeo@rutgers.edu

Project Abstract: Surfing requires a high level of fitness to paddle with sufficient speed and power to catch green waves as they break. For beginning and intermediate surfers, paddling with sufficient speed can be challenging and lead to difficulty in popping up to catch waves and develop skills. This project will focus on the design and manufacture of a detachable propulsion unit that can fit on the underside of surfboards of varying size. The goal is not to create a fast-traveling vehicle but provide enough power in a portable, lightweight attachment to allow surfers to catch waves automatically based on the measured paddling rate of the surfer's arms. Future applications may include systems that assist lifeguards in rescue of drowning surfers.

Project Goals: Create a safe and lightweight system for hydraulic propulsion. Create a control system that uses wireless accelerometers mounted on the upper arm to determine when to power the propulsion system. Collect information from the surfer to then aid in customized instruction.

Project Envisioned Outcomes: Detachable propulsion system. Control system with wireless accelerometers; Data science to aid beginning surfers and help them learn to surf more quickly; Low-cost prototype that we can think about marketing.

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:

Two teams -- one focusing on propulsion; one focusing on the accelerometers.

ME PROJECT 20

Detachable Propulsion Unit for Surfboards of Varying Size II

Advisor: Prof. Aaron Mazzeo

Email: aaron.mazzeo@rutgers.edu

Project Abstract: Surfing requires a high level of fitness to paddle with sufficient speed and power to catch green waves as they break. For beginning and intermediate surfers, paddling with sufficient speed can be challenging and lead to difficulty in popping up to catch waves and develop skills. This project will focus on the design and manufacture of a detachable propulsion unit that can fit on the underside of surfboards of varying size. The goal is not to create a fast-traveling vehicle but provide enough power in a portable, lightweight attachment to allow surfers to catch waves automatically based on the measured paddling rate of the surfer's arms. Future applications may include systems that assist lifeguards in rescue of drowning surfers.

Project Goals: Create a safe and lightweight system for hydraulic propulsion. Create a control system that uses wireless accelerometers mounted on the upper arm to determine when to power the propulsion system. Collect information from the surfer to then aid in customized instruction.

Project Envisioned Outcomes: Detachable propulsion system. Control system with wireless accelerometers; Data science to aid beginning surfers and help them learn to surf more quickly; Low-cost prototype that we can think about marketing.

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:

Two teams -- one focusing on propulsion; one focusing on the accelerometers.

ME PROJECT 21

Controlling the Stiffness of 3D Printed Pieces

Advisor: Prof. Andrew Norris

Email: norris@rutgers.edu

Project Goals: The goal is to make soft objects from a 3D printer that normally produces stiff pieces. It will involve some knowledge of the software that generates the CAD files for the 3D printer.

Project Envisioned Outcomes: To allow us to use a printer that makes stiff pieces to make ones that are softer, using the same input material, e.g. filament PLA.

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:

Knowledge of FEM is very useful.
https://dl.acm.org/doi/pdf/10.1145/2766926

ME PROJECT 22

Electrooptical System for Measuring and Characterizing High Strain Rate Impact Deformations

Advisor: Prof. Assimina Pelegri

Email: pelegri@rutgers.edu

Please contact Prof. Pelegri for project details

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	☑				

ME PROJECT 23

Design and Manufacturing of Cellulose Fiber Spinning Equipment

Advisor: Prof. Assimina Pelegri

Email: pelegri@rutgers.edu

Please contact Prof. Pelegri for project details

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	☑				

ME PROJECT 24

Test Stand for Thermal Characterization of Battery Cells

Advisor: Prof. Amin Reihani

Email: amin.reihani@rutgers.edu

Project Goals: The objective of this project is for the students to construct and calibrate a test setup to accurately measure the in-plane and through-plane thermal conductivity of Li-ion pouch cells, as well as 2D distribution of temperature in individual cells during charging/discharging cycles. The test setup will require utilizing low-noise analog circuits, flexible heaters and a thermal camera connected to a LabView program to operate the test setup and record the data. The test setup needs to be reconfigurable to allow measurements on cells with different dimensions.

Project Envisioned Outcomes: The outcome of the project is a reconfigurable test setup which can accurately characterize the thermal properties of operating li-ion pouch cells. The students will conduct measurements on at least two different types of battery cells, compile the raw data and present them in appropriate graphs. Successful measurements from this instrument will aid the development of accurate thermal models of battery cells and design of advanced battery management systems.

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	☑				

ME PROJECT 25

Vacuum Tube Solar Steam Generator

Advisor: Profs. Todd Rossi, Michael Muller

Email: todd.m.rossi@rutgers.edu,

Project Abstract: Solar thermal energy collectors are more appropriate than PV for industrial heat driven processes (e.g., water desalination). In this project, we will enhance, build, and operate a vacuum tube solar steam generator at 15 psi.

Project Goals: 1) Update design and build 15 psi solar steam generator prototype, 2) Operate, test, and measure performance, 3) Refine design as needed, 4) Setup continuously operating outdoor prototype with instrumentation, automated controls, and remote monitoring.

Project Envisioned Outcomes: Continuously operate a 15 psi solar steam generator with automated controls and remote performance monitoring and reporting

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://drive.google.com/drive/folders/18ZTBnLddnsjitu4uhlxUGKu2hgHAAfg8?usp=sharing

ME PROJECT 26

Composites Manufacturing

Advisor: Prof. Jonathan Singer

Email: jonathan.singer@rutgers.edu

Project Goals: Students will be given the choice of whether to work on a project related to spray-based scratch repair or energetic composites.

Project Envisioned Outcomes: Scratch repair project will look to create a stand alone system to repair damage to automotive coatings (i.e. scratched paint). The energetics project will look to test combustion of composite materials developed in our lab. Both of these projects will build from existing capstone results (from 2022 and 2024 respectively).

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	☑				

ME PROJECT 27

Mechanical Harmonic Analyzer to do Fourier Transforms using Legos or K'nex.

Advisor: Prof. Stephen Tse

Email: sdytse@rutgers.edu

Project Goals: The mechanical harmonic analyzer is an analog computer that can do Fourier Transforms. It uses gears, pulleys, springs, levers, etc., to perform the calculations. After examining Albert Michelson's original design, the group will design a modified compact version using standard parts from Legos, K'nex, or other building sets. Some custom parts may be made using additive manufacturing.

Project Envisioned Outcomes: The device should be able to do series/transforms for up to 10 coefficients. For demonstration, it should do some standard waveforms, along with a possible mp3 of a simple song.

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://www.youtube.com/watch?v=GyYflzRVu6M

ME PROJECT 28

Non-Destructive Material Discontinuity Detection Artificial Intelligence Device

Advisor: Prof. Nikolaos Vlassis

Email: nick.vlassis@rutgers.edu

Project Goals: To develop a compact, cost-effective non-destructive testing device that utilizes AI to detect material discontinuities. The device will be designed such that it can be assembled and operated easily by engineering students, with comprehensive documentation provided.

Project Envisioned Outcomes: A prototype of the non-destructive testing device accompanied by comprehensive documentation for assembly and use. This will include detailed specifications for hardware components, software, including AI algorithms, and instructions for integrating these components to ensure accurate detection of material discontinuities.

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			☑		

ME PROJECT 29

Design of Strong and Lightweight Cylindrical Pressure Vessel Using Carbon Fibers and Epoxy Resin

Advisor: Prof. George Weng

Email: gjweng@rutgers.edu

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

Project Envisioned Outcomes: A hardware composite cylindrical 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	☑				

ME PROJECT 30

Robotics (Title TBD)

Advisor: Prof. Jingang Yi

Email: jgyi@rutgers.edu

This project was proposed by a group of students and is closed.

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., vaccum 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					

ME PROJECT 31

Development of Electrochemiluminescent Microscopy for Nanosensing and Single Cell Dynamics Characterization

Advisor: Prof. Qingze Zou

Email: qzzou@rutgers.edu

Project Goals: In this project, we seek to design, construct, and test an electrochemiluminescent (ECL) microscope for nanosensing and biological-related applications to characterize single cell dynamics. ECL microscopy utilizes the luminescence signal generated in electrochemical reactions to detect a wide range of inorganic and organic species at micro to nano scale. Coupling with high-resolution optical microscope, ECL recently has been explored for investigating dynamic material reactions and biological interactions at sub-micrometer to nanometer scale, becoming a powerful tool for a wide range of studies including biosensors, battery development in renewable energy, to inter-cellular interactions in a single cell. In this project, we will integrate the ECL microscope to an atomic force microscope (AFM) to combine both measurements on the same platform, thereby, offering nanoscale measurement capability previously not possible.

Project Envisioned Outcomes: Your group will design the ECL device consisting of electrical circuit and mechanical structure (sample holder) for exciting and generating the ECL signal, fabricate and build the ECL device, integrate it to AFM, and then conduct preliminary experiments to test and validate its function in renewable energy and cellular biology studies.

Students Expertise: (Please discuss with Prof. Zou)

	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: (Please discuss with Prof. Zou)

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