Project Title:
Eligibility Criteria in Clinical Studies

Project Abstract:

Domain Background

Pharmaceutical and Medical Device organizations are required to prove evidence of safety and efficacy via studies (aka clinical trials). A study protocol has guidelines for who can or cannot participate in the study. These guidelines, called eligibility criteria, describe characteristics that must be shared by all study participants. The criteria differ from study to study. They may include age, gender, medical history, and current health status. Enrolling participants with similar characteristics ensures that the study results provide a consistent measure for the intended statistical hypothesis of the study.

Eligibility criteria need to balance two competing forces. They must be strict enough to ensure a study population that supports a high quality analysis of the study statistical analysis (i.e., find the right participants). They must not be overly restrictive, so that study enrollment and feasibility is not negatively impacted (i.e., find sufficient participants).

Goals

Within the context of the above domain constrains, the goals of this project are twofold:

- Identify a means by which candidate eligibility criteria (both inclusion and exclusion) can be harvested from existing public domain trial registries (e.g., CT.gov, NIH/NCI) and aligned with a to-be-defined information model suitable for full-fidelity representation within Nurocor’s Nurocor Clinical Platform (NCP), a clinical study design software platform. Natural Language Processing (NLP) and other AI techniques are likely to be useful in achievement of this goal.
- Evaluate the effectiveness of candidate eligibility criteria for a specific study under development, based in part on publicly available trial datasets applicable to the Therapeutic Area and Indication for which the study under development is being specified. Machine Learning techniques are likely to be relevant in the achievement of this goal.

Expected Deliverables:

- Prerequisite (to be provided by Nurocor)
- Provide contextual information about dependencies and relationships of eligibility criteria as they apply to study properties (e.g. therapeutic area, indication, study phase, study type) and statistical analysis (e.g. endpoints, study population)

Deliverable 1: Develop a standard library for Eligibility Criteria

- Formalize eligibility criteria (pattern, structure, syntax, semantics, representation, templates, ontology, computable queries, ML features)
• Investigate a structure for abstract criteria with a translation to inclusion criteria (positive) and exclusion criteria (negative)
• Compare representations in existing submission requirements, industry standards, and registries
• Identify sources of eligibility criteria of existing trials (registries, CT.gov, NIH/NCI)
• Define a common format to extract eligibility criteria
• Analyze eligibility across sources (textual representation, distribution, variations)
• Create annotated mappings from textual to formal representations

Deliverable 2: Qualify Eligibility Criteria in the context of a given study

Develop a scoring or evaluation algorithm to determine the quality and restrictiveness of eligibility criteria for a given study definition. When considering the quality of eligibility criteria, the following factors need to be considered:

1. Relationship to scientific objective
   • Does the eligibility criterion support the scientific hypothesis?
   • Could the scientific goal be achieved without including this particular eligibility criterion?
2. Generalizability
   • Will the results of the study be applicable to a patient not enrolled on the study?
   • Are the eligibility criteria too restrictive for clinical use?
3. Patient safety and drug toxicity
   • Is patient safety being adequately protected and does this eligibility criterion contribute to this?
   • Are potential drug toxicities and mechanism of action being accounted for and does limiting or including this criterion support or hinder the scientific goal?
4. Continual review on a regular basis
   • At what point should eligibility criteria be re-justified during protocol development and during enrollment?
   • Is it possible to do a study post mortem and make adjustments for upcoming studies in the same clinical program or across programs?

Specialized Resources Provided by Client:

Anticipated Cost: ___________________________ Financial Resources Provided by Client: $1000 (Nurocor is a startup SW ISV)

Preferred Students for the Project:

☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☑ Other: Computer Science

Other Special Skills: Background in AI technologies and techniques

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

<table>
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On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj001

☐ Project Assigned: ____________________________

☐ Advisor(s) Assigned: ____________________________

______________________________________________
Project Title: Applying and Evaluating Blockchain in Energy Delivery Systems

Project Abstract:

The inherent capabilities within Blockchain technologies provides the potential to secure communications and hold immutable information to prevent cyber attacks attempting to spoof and/or manipulate process controls. The team would extend prior efforts in deploying a HyperLedger Fabric Blockchain network to integrate the blockchain directly with devices in the PowerCyber lab at ISU ECpE and to design multi-level methods for evaluating blockchain performance and fit for energy use cases. The team would update smart contracts and integrate directly with devices such as PMU's and identify tools such as Caliper for measuring blockchain performance. The team would grow smart contract and API end point programming skills in Java Script/Python, User Interfaces, Docker/Swarm container management, and network based communications in Energy Delivery Systems.

Expected Deliverables:

Use Case Demonstration
All Software Code and Settings
Documentation as planned for the class, findings, and recommended next steps

Specialized Resources Provided by Client:

None anticipated, access to PowerCyber from ISU faculty sponsor, ETG virtual resources

Anticipated Cost: Financial Resources Provided by Client: 0

Preferred Students for the Project:

☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☑ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddec21-proj002
☐ Project Assigned:  
☐ Advisor(s) Assigned:  
Co-Simulation of an Avionics Interface Device

**Project Abstract:**

The project will take an existing co-simulation solution which uses a SystemC TLM + QEMU (https://xilinx-wiki.atlassian.net/wiki/spaces/A/pages/28737647/QEMU+LibSystemCTLM-SOC) coupled with a product firmware definition. The goal for the team is to implement additional backend SystemC simulations and frontend test software to exercise the new logic. The tooling for the project will use Xilinx QEMU, SystemC 2.3.2 and Xilinx SystemC TLM libraries. An existing architecture will be shared that outlines some proprietary logic and interface behaviors coupled with the Xilinx solution.

**Expected Deliverables:**

I do have some schedule constraints where I can fund hands on advising of this work in 2021 if the project starts for Spring semester. My plan was to sponsor weekly meetings with a Linux and firmware expert on the call to help the team.

For the 1st semester the goal would be to get an understanding of the concepts and to do some basic additions.

1) Extend an existing use case that receives data (simulated firmware -> processor) to also include a transmit (processor -> simulated firmware).
2) Build a UDP bridge to send/receive data from the SystemC model (used to support dataflows in the memory map interface model)

The 2nd semester will look into adding additional sensors and protocol definitions in simulated firmware + software.

1) A temperature sensor and the development of a Linux driver
2) ARINC 717 receiver and basic Linux test application
3) Stretch goal of implementing a UART and hooking it into the Linux serial subsystem

**Specialized Resources Provided by Client:**

None. The technology is completely open and a standard Linux machine can be used for development/run-time. Only specialized item would be ICD definition of a FPGA design used to develop new simulation models.

**Anticipated Cost:**

I can easily commit $5k if invoiced in 2020

**Preferred Students for the Project:**

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering

**Other Special Skills:**

- Xilinx Zynq, Linux Apps, Linux Kernel Drivers, QEMU, Cross compiling, Python, C, C++, SystemC
Anticipated Client Interaction (estimate):

- ☑ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

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This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

Project Approval – for use by ECpE Senior Design Committee

- ☑ Approved: sddec21-proj003
- ☐ Project Assigned: ________________________________
- ☐ Advisor(s) Assigned: ________________________________
Project Title: Electronic Golf League Scheduler

Project Abstract:
I am interested in a scheduling system for my women's golf league in which we can enter individual/team names, create an initial schedule along with hole assignments for a summer golf league. The system will need to be able to account for absences and/or change in partners from week to week (think on the fly) and keep track of who has played who along with which holes they have started on. If it could also keep track of team scores from week to week along with pin prize winners, that would be a bonus. The system will have to be user friendly for "non techy" people.

Expected Deliverables:
If we could have something in place for the Spring/Summer 2022 league that would be great. Spend the first semester reviewing what we currently use and determine what free options are out there. By then end of spring semester have an idea of what platform to be used to build. By end of Fall 2021, have a finished product.

Specialized Resources Provided by Client:
Don't really have any other than spreadsheets we have used in the past.

Financial Resources Provided by Client: person.

Anticipated Cost: 

Preferred Students for the Project:
☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other: Ability to make something techy for non-techy users.

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Sorry I am a poor university staff person.
### Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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### Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj004

☐ Project Assigned: _______________________________________________________

☐ Advisor(s) Assigned: ___________________________________________________
Senior Design Project Proposal Form

Client/Company/Organization:  ECpE Student Services

Submitter Name:  Tina Prouty  Email:  tmprouty@iastate.edu

Project Title:  Electronic Program of Study (POS) Form

Project Abstract:
As you know, in SE, EE, CprE 166 you are required to submit a POS. The current "forms" we use can be a bit clunky. We would like a form, that can be updated easily, to use in 166 that has drag and drop along with other features to try to make the process easier on the student and the instructor.

Expected Deliverables:
We would like to have a final form ready for S22. Testing can be done F21 as CprE/EE 166 is offered the second half of the semester. S21 semester can be spent looking at what we have used in the past, options for student services staff to update and begin building. F21 first half can be spent building, second half could be for testing if ready.

Specialized Resources Provided by Client:
Can provide what we have used and what we know about programming (not a lot)

Anticipated Cost:  Budget would be from the department

Financial Resources Provided by Client:  ☑

Preferred Students for the Project:
☐ Electrical Engineering  ☑ Computer Engineering  ☑ Software Engineering  ☐ Cyber Security Engineering  ☐ Other:

Other Special Skills: Ability to make this very non-techy for upkeep

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  |  1 – A Little  |  2 – Somewhat  |  3 – A Lot  |  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0  ☐ 1  ☑ 2  ☐ 3  ☐ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:   sddec21-proj005
☐ Project Assigned:
☐ Advisor(s) Assigned:
Senior Design Project Proposal Form

Client/Company/Organization: Buildertrend

Submitter Name: Gina Saccoman Email: gina.saccoman@buildertrend.com

Project Title: Performance Monitoring Header

Project Abstract: Create a way to find and expose data and patterns as the developers are working.

Expected Deliverables: We will meet at least bi-weekly, will have teams chat to work along with the team as needed, and can set up milestones as the semester progresses.

Expected deliverables:
- Create a toolbar / sticky header on a website to display performance and other metrics
- Make the toolbar flexible enough to add / remove metrics as needed
- Develop an extensible system for passing data from the backend to the toolbar for display
- Stretch goal: save data to a database, add baselines, alerts

Specialized Resources Provided by Client:

Anticipated Cost: Financial Resources Provided by Client: 

Preferred Students for the Project:
- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

Anticipated Client Interaction (estimate):
- ☑ 2 or more meetings per month
  - ☑ In person, ☑ Over the phone, ☑ Web / video conferencing
- ☐ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Other Special Skills:
### Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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### Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  

sddec21-proj006

☐ Project Assigned:


Advisor(s) Assigned:  


Senior Design Project Proposal Form

Client/Company/Organization: Buildertrend

Submitter Name: Gina Saccoman Email: gina.saccoman@buildertrend.com

Project Title: Project Measurement/Parameters Used in Estimate Formulas

Project Abstract:
Create the ability for a user to calculate line item quantities in the estimate using formulas

Expected Deliverables:
We will meet at least bi-weekly, will have teams chat to work along with the team as needed, and can set up milestones as the semester progresses.

Expected Deliverables:
o Re-create a simplified version of our line item container on a sample site
o Create a UX that allows for insertion of parameters and formulas into the various line item fields
o Determine the best way to store these values for best performance and reporting ability
  - Consider how these formulas might show up on a financial report
o Create an administration page to create and update the parameter values

Specialized Resources Provided by Client:

Anticipated Cost: Financial Resources Provided by Client:

Preferred Students for the Project:
☐ Electrical Engineering
☐ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
  ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
  ☑ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
Senior Design Project Proposal Form

☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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On this project, students will need to apply knowledge of mathematics, science, and engineering
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☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj007

☐ Project Assigned: 

☐ Advisor(s) Assigned: 

________________________________________

________________________________________
Client/Company/Organization: Buildertrend

Submitter Name: Gina Saccoman  Email: gina.saccoman@buildertrend.com

Project Title: Docusign Integration

Project Abstract:
Utilize the Docusign API inside of the documents portion of Buildertrend to allow for additional signatures between homeowner, subs, and our builders

Expected Deliverables:
We will meet at least bi-weekly, will have teams chat to work along with the team as needed, and can set up milestones as the semester progresses.

Explore the API and create a sample site

Specialized Resources Provided by Client:

Anticipated Cost:  Financial Resources Provided by Client:  

Preferred Students for the Project:
☐ Electrical Engineering  ☑ Software Engineering
☐ Computer Engineering  ☐ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):
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☐ 1 meeting per semester
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Meeting ABET Criteria
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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: ☐ Project Assigned: ☐ Advisor(s) Assigned:
Client/Company/Organization:   Buildertrend

Submitter Name: Gina Saccoman                    Email: gina.saccoman@buildertrend.com

Project Title:                        
Integration with Team/Zoom Chat

Project Abstract: Utilize API’s to integrate Zoom/Teams into Buildertrend for additional communication feature/functionality

Expected Deliverables: We will meet at least bi-weekly, will have teams chat to work along with the team as needed, and can set up milestones as the semester progresses.
Explore the API and create a sample site

Specialized Resources Provided by Client:

Anticipated Cost:  
Financial Resources Provided by Client:  

Preferred Students for the Project:
☐ Electrical Engineering
☐ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 2 or more meetings per month
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria
Please rate the following statements as they relate to your proposed project:

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj009

☐ Project Assigned:

☐ Advisor(s) Assigned:
Project Title: Static Site Generation

Project Abstract:

- We want to provide an easier process for clients to build and maintain their company websites. We feel that allowing clients to easily set up and maintain a company website via an administrative panel will increase the usage of this feature, as well as provide our clients a custom website building experience so they can stand out in their respective markets.
- Provide users easy to use templates that will allow them to easily pull together a company website, and also allow them to maintain this through the life of their time at BT.
- Have this update appear in the settings menu, so the client remains in BT while updating information.

Expected Deliverables:

- We will meet at least bi-weekly, will have teams chat to work along with the team as needed, and can set up milestones as the semester progresses.

- Build out of initial Next.js templates in react
  - Home, Blank, Gallery, Showcase, Blog, Login, Contact
  - Blank template example content
    - About/Employee, Floor Plan, Testimonials, Services, Privacy Policy, Process
  - Only image uploads supported - not docs
  - There will be some Themes available

- A process to test template changes and ‘publish’ them
  - Could be manual for initial implementation, but may be fairly straight forward with DevOps/Octopus

- Builder setup page to edit basic content that feeds the templates
  - Includes API to save/retrieve the template data
  - Basic info for each individual page
    - Title, template, tags/metadata, menu order, grouping (not needed initially)
  - Menu
    - Every page will be a main navigation item, builder can re-order items
      - Blogs are the one exception, the blog template will have articles within it

- Triggered static site generation and publish (Not needed for the single site options)
  - On some action (either data update or user button click), the site will be regenerated and published

- Support for Custom Domains
  - Template Maintenance/Bug Fixes (Not needed for the single site options)
    - Process to re-generate sites after template/framework updates

- Custom Domain/SSL Setup
  - Depends on implementation, but can support both
  - Most likely a default domain for every site, then custom can be added as requested
**Senior Design Project Proposal Form**

**Specialized Resources Provided by Client:**

**Anticipated Cost:** ____________________  **Financial Resources Provided by Client:** ____________________

**Preferred Students for the Project:**

- ☐ Electrical Engineering
- ☐ Computer Engineering
- ✓ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other: ____________________

**Other Special Skills:** ____________________

**Anticipated Client Interaction (estimate):**

- ☐ 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ☐ 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- ✓ 2 or more meetings per month
  - ☐ In person, ☐ Over the phone, ✓ Web / video conferencing
- ☐ 1 meeting per semester
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

**Meeting ABET Criteria**

Please rate the following statements as they relate to your proposed project:

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj010

☐ Project Assigned:

☐ Advisor(s) Assigned:
Client/Company/Organization: DigiClips

Submitter Name: Bob Shapiro Email: bobshapiro40@gmail.com

Project Contact: Bob Shapiro Email: bobshapiro40@gmail.com

Project Title: DigiClips Media Search Engine

Project Abstract:
Problem we need solved we are working on developing a Media Search Engine and related software for Television, Radio, Newspapers, Magazines, Social Media, Blogs, and Web Media. Software to be familiar with would be Ubuntu-Mate 18.04 or 20.04, C, nodejs, react, angular 9, typescript, plus familiar with AWS Amazon.

Expected Deliverables:
After semester

Specialized Resources Provided by Client:
We provide Zoom and google hangout weekly meetings, plus email and communications are always available.

Due to Covid 19 sadly we do not have the

Anticipated Cost: ___________ Financial Resources Provided by Client: capital.

Preferred Students for the Project:
☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: Software to be familiar with would be Ubuntu-Mate 18.04 or 20.04, C, nodejs, react, angular 9, typescript.

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
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Meeting ABET Criteria
Please rate the following statements as they relate to your proposed project:

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On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0   ☐ 1   ☐ 2   ☐ 3   ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
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This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0   ☐ 1   ☐ 2   ☐ 3   ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0   ☐ 1   ☐ 2   ☐ 3   ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0   ☐ 1   ☐ 2   ☐ 3   ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:        sddec21-proj011
☐ Project Assigned: ________________________________
☐ Advisor(s) Assigned: ________________________________

_____________________________________________
Project Title: BeagleBone Green Gateway IoT Hub

Project Abstract:
Learn the entire process of bringing an electronics kit to market! Over the course of the project, the team will design a robust, programmable, open source gateway board to aid Internet of Things developers starting on new connected products. The team will work with the BeagleBone Green Gateway as a starting point for a multi-access gateway. This hardware will function as a connectivity hub for wireless sensors or as a standalone connectivity hotspot for industrial use cases. The team will iterate the design to improve the user “out of box” experience. This could include integration with popular ecosystems, adding connectors, adding on-board features such as sensors, or adjusting the physical size and programming interface to address market trends. When the hardware is finalized, the team will use Whole Product development philosophy to create the necessary marketing materials and software examples to ensure a positive experience with users. The team will also design or research any accessory components that will be included in the final kit, which could include a custom enclosure, connectors, cables, power supplies, stickers, and other necessary parts.

Expected Deliverables:
* Open Source Bill of Materials designed for quality, performance, and low cost
* Functional prototype development board fully assembled
  -- Supplemental Wireless radio or wireless dongle
  ---- Examples: LTE, Wi-Fi, Zigbee
  -- Optional Open Source PCB board layout in CAD tool (EAGLE, KiCad, Upverter, or Altium)
  ---- Examples: Accelerometer, tilt switch, temperature, light, GPS
  -- Clear silkscreen labeling of important board markings for users
* Documentation to bring up board in a user manual or quick start guide
  -- Include pin map diagram
  -- Include color photo of final board
  -- Explanation of out of box demo or default program
* At least 5 demo code examples with documentation
  -- Blink LED, read sensor, initialize wireless communication, send sensor data to cloud
* Written list or physical prototypes of accessories for the development board which could include a custom enclosure, connectors, cables, power supplies, stickers, and other necessary parts

Specialized Resources Provided by Client:
* Customer Provided Equipment
  * BeagleBone Green Gateway and accessories for evaluation and prototyping
  * Code Composer Studio IDE
  * TI Integrated Circuit and EVM samples
Senior Design Project Proposal Form

Anticipated Cost: ___________________________  Financial Resources Provided by Client: Yes we are open to funding.

Preferred Students for the Project:

☑ Electrical Engineering  Other Special Skills: *Linux device drivers
☑ Computer Engineering  *Microcontrollers, microprocessors, and firmware
☐ Software Engineering  *Digital and analog sensor interfacing and development
☐ Cyber Security Engineering  *Web or Mobile development
☐ Other:

Anticipated Client Interaction (estimate):

☐ 1 meeting per week
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☑ 2 or more meetings per month
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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On this project, students will need to apply knowledge of mathematics, science, and engineering
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This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
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This project involves students from a variety of programs, i.e., CprE, EE, and SE
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This project requires students to identify, formulate, and solve engineering problems
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This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee
Senior Design Project Proposal Form

☑ Approved:  sddec21-proj012

☐ Project Assigned:  

☐ Advisor(s) Assigned:  

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____________________________________________________________________
Project Title: IoT Sensor Project

Project Abstract:
Learn the entire process of bringing an electronics kit to market! Over the course of the project, the team will design a full stack sensor network demonstration. One objective is to design a custom small form factor, programmable, open source microcontroller board OR a custom daughter board to a microcontroller development kit to aid Internet of Things developers creating a scalable wireless sensor. The team will decide to design their own PCB board in a CAD tool and work through the process of prototyping and assembly of the hardware or to utilize existing demo hardware and focus on network topology and network design. The team will iterate the design to improve the user “out of box” experience. This could include integration with popular ecosystems, adding connectors, adding on-board features such as sensors, or adjusting the physical size and programming interface to address market trends. When the hardware is finalized, the team will use Whole Product development philosophy to create the necessary marketing materials and software examples to ensure a positive experience with users. The team will also design or research any accessory components that will be included in the final kit, which could include a custom enclosure, connectors, cables, power supplies, stickers, and other necessary parts.

Expected Deliverables:

* Open Source Bill of Materials designed for quality, performance, and low cost
* Option A: Functional prototype development board with microcontroller design OR functional daughter board attached to microcontroller development board
  -- Open Source PCB board layout in CAD tool (EAGLE, KiCad, Upverter, or Altium)
  -- TI MCU
  -- TI Wireless radio
  -- Headers for prototyping on breadboard
  -- Sensor
    ---- Examples: Accelerometer, tilt switch, temperature, light, GPS
  -- Clear silkscreen labeling of important board markings for users
  -- Programmable by FET tool, OTA, USB, or TI LaunchPad
* Option B: Selected demo hardware connected via network from sensor to cloud
  -- TI LaunchPad based solution
  -- Use of BoosterPacks or sensor modules for complete wireless sensor demo
  -- Sensor
    ---- Examples: Accelerometer, tilt switch, temperature, light, GPS
  -- Connection of sensor to Gateway or Router and then to cloud service
    ---- Examples: Wi-Fi, LTE, Zigbee, Thread
  -- Use of professional cloud tools to display and organize sensor data
* Documentation to bring up sensor board in a user manual or quick start guide
  -- Include pin map diagram
  -- Include color photo of final board
  -- Explanation of out of box demo or default program
Senior Design Project Proposal Form

*At least 5 example code samples with documentation
--Blink LED, button input, read sensor, initialize wireless communication
--Can be based on TI code examples provided for MCU
--Make available for Code Composer Studio

*Written list or physical prototypes of accessories for the hardware setup which could include a custom enclosure, connectors, cables, power supplies, stickers, and other necessary parts

Specialized Resources Provided by Client:

Customer Provided Equipment
*TI LaunchPad and BoosterPack kits for evaluation and developing software
*Code Composer Studio IDE
*TI Integrated Circuit samples

Anticipated Cost: ______________________ Financial Resources Provided by Client: funding

Preferred Students for the Project:

☑ Electrical Engineering
☑ Computer Engineering
☐ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: *Circuit design and PCB layout
*Microcontrollers and firmware
*Digital and analog sensor interfacing and development
*Web or Mobile development

Anticipated Client Interaction (estimate):

☐ 1 meeting per week
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 2 or more meetings per month
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☐ 1 meeting per semester
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Meeting ABET Criteria

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This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4
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This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☑ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddc21-proj013

☐ Project Assigned:  

☐ Advisor(s) Assigned:  

____________________________________

____________________________________

____________________________________
Senior Design Project Proposal Form

Client/Company/Organization: Daji Qiao (ECpE, ISU)

Submitter Name: Daji Qiao (ECpE, ISU)   Email: daji@iastate.edu

Project Title: Magic Sensors

Project Abstract:
Currently in the market, window/door sensors (used in home security systems) usually are battery powered or need to be wired to a control unit. The goal of this project is to design and implement innovative "magic sensors" which are wireless and batteryless. In other words, these "magic sensors" shall be able to "report" the status of the window/door (whether it is open or closed) wirelessly to the control unit without a power source (such as battery). One possible approach is to detect the shape of the sensor (hence status of the door) based on the way how wireless signals are reflected by the sensor; CSI (Channel State Information) will be used to analyze the wireless signals. This project is a continuation from a previous senior design project sddec2018.

Expected Deliverables:
To deliver a proof-of-concept prototype system by the end of May 2021, and a refined version by November 2021.

Specialized Resources Provided by Client:
Multiple units of ESP32 devices that can be used to collect CSI information.

Anticipated Cost:   Financial Resources Provided by Client:

Preferred Students for the Project:
☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☑ Other: 3~4 Cpr E/S E, and 1~2 E E in total.

Other Special Skills: C/Matlab programming, Embedded systems and networking devices. Data analytical tools such as machine learning and statistics. Antenna and circuit design.

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 2 or more meetings per month
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Meeting ABET Criteria
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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj014
☐ Project Assigned: 
☐ Advisor(s) Assigned: 
Utility Scale Lithium-Ion Energy Storage Project

Based on current and predicted renewables penetrations in the US, there is an increasing need to add energy storage to the electrical grid. This project examines currently available energy storage technology and employs that technology on a grid-scale lithium-ion battery storage project. The project fully encompasses the electrical aspects of an energy storage design project from technology selection through the development of engineering deliverables needed for construction.

Expected Deliverables:

Project will include an initial technology selection focusing on different lithium-ion battery chemistries/characteristics and various deployment strategies on the market. Based on the technology selection, the lithium-ion battery will be sized including such concepts as overbuild and augmentation, round-trip efficiencies, etc. After battery sizing, a compatible inverter will be selected and a site layout and an electrical one-line will be produced. Site layout will include provisions for both NFPA 855 and UL 9540A. Based on battery drawings from the lithium-ion battery OEM, detailed drawings will be produced for each battery bank. Detailed design will include conductor sizing, low flow/short-circuit/arc flash studies, cable schedule, and connection diagrams. If time allows, construction logistics and planning will be included.

Specialized Resources Provided by Client:

Burns & McDonnell will provide lithium-ion battery expertise and electrical design/construction expertise.

Anticipated Cost: Agreed

Preferred Students for the Project:

☐ Electrical Engineering
☐ Computer Engineering
☐ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: General electrical engineering knowledge. Electrical study experience (load flow, short circuit, etc.) would be helpful but is not required.

Anticipated Client Interaction (estimate):

☐ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
Meeting ABET Criteria

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj015

☐ Project Assigned: 

☐ Advisor(s) Assigned: 
Senior Design Project Proposal Form

Client/Company/Organization: Iowa State University - ADINO Lab

Submitter Name: Timothy Bigelow  Email: bigelow@iastate.edu

Project Contact: Timothy Bigelow  Email: bigelow@iastate.edu

Project Title:
Powder Bed Metal Printer

Project Abstract:
The primary goal of this project is to print stainless steel cubes in our custom powder bed system. Prior groups have done a lot of the work, but the software needs to be reworked and the control of the melt laser needs to be incorporated. Being able to print any 3D object would be a secondary goal.

Expected Deliverables:

Deliverable 1: Rewrite code from object oriented programming to functional programming. The current code is written in C# using object oriented programming. However, this is not sustainable by myself and my graduate students who typically have a more functional programming background. Also, finding a C# compiler has been challenging in the past once the semester ended. Therefore, we want the code re-written in MATLAB or LABVIEW, so that we can continue to modify the code once the basic objectives are achieved. (End of 1st semester)

Deliverable 2: Incorporate melt laser control. The prior code controlled the motion of the printer and the translation of geometry files into motion. There was some incorporation of sensors/sensor monitoring, but it was not effectively demonstrated. (Middle of 2nd Semester)

Deliverable 4: Print metal cubes with the printer. (End of 2nd Semester)

Specialized Resources Provided by Client:
All the hardware for the metal printer is available and in-place.

Anticipated Cost: Thousands of dollars
Financial Resources Provided by Client: in equipment.

Preferred Students for the Project:

☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: Need to know both object oriented and functional programming

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
  ✔ In person,  ☐ Over the phone,  ☐ Web / video conferencing

☐ 1 meeting per month
  ☐ In person,  ☐ Over the phone,  ☐ Web / video conferencing

☐ 2 or more meetings per month
Meeting ABET Criteria

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj016

☐ Project Assigned:

☐ Advisor(s) Assigned:
Project Title:
Making Recipes Readable Again

Project Abstract:
Recipes have been presented in a variety of forms over the years, from index cards to books to HTML. However, digital recipes, particularly those found on recipe websites and blogs, tend not to make full use of the power of digital, programmatic representation. Even worse, many recipe websites display recipes in a manner that is considerably harder to follow than traditional paper-based representations. This project aims to develop a tool to make existing digital recipes (i.e. those already posted on the Internet) more readable without intruding on the original author's intent (or monetization opportunities). The tool must be widely accessible by a non-technical audience. The tool may take the form of a browser plugin, a mobile app, or something else proposed by the team. The core of the project is expected to include elements of natural language processing and web scraping/DOM modification.

Expected Deliverables:
February: research into platforms and NLP
March: platform selection and proof-of-concept
April: proof-of-concept deliverable
September: implementation
October: implementation and testing
November: final tool deliverable

Specialized Resources Provided by Client:

Anticipated Cost: ___________________________  Financial Resources Provided by Client: ___________________________
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
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This project requires students to identify, formulate, and solve engineering problems
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  

☐ Project Assigned:  

☐ Advisor(s) Assigned:  

sddec21-proj017
Project Title: Adversarial AI to Prevent Microarchitectural Website Detection Attacks

Project Abstract:
Microarchitectural attacks have shown that shared hardware resources such as cache, branch predictors, physical memory etc. can be exploited to learn secrets. While these attacks have been demonstrated to steal cryptographic keys and passwords from kernel, they can also be used to violate the privacy of the users. For instance, malicious websites, that are open in a browser, can track user activity in the same browser or other browsers by monitoring cache usage through running Javascript code in the browser.[18]

At the same time, cache usage data of the visited websites is analyzed with Machine Learning or Deep Learning algorithms to achieve a higher detection rate. Unfortunately, these attacks violate the user privacy in browsers and current browsers have no detection/prevention mechanisms for microarchitectural attacks. This project aims to build a Javascript-based noise mechanism to alter the cache usage data intelligently to prevent the Deep Learning-based website detection attacks.

The team will:
1) Develop a Javascript-based cache usage monitoring code
2) Develop a Deep Learning-based website detection mechanism
3) Offer a mathematical solution to change cache usage dynamically when a website is visited
4) Implement the mathematical solution in the Javascript code
5) Analyze the performance overhead on system benchmarks

Students will employ knowledge and skills they have developed throughout their time at ISU and will need to create their own solutions to protect user privacy on internet. They will make use of a number of analysis tools, programming languages, and mathematical background such as Matlab, Python, Tensorflow, Javascript, probability and so on.

Expected Deliverables:
- A Javascript code to monitor cache usage while visiting web pages in a browser
- Deep Learning-based detection tool to detect web pages
- A Javascript code to prevent website detection on a browser

Specialized Resources Provided by Client:
Access to the laptop over Teamviewer will be given to the team for writing Javascript codes and data collection. Access to a GPU machine will be given to the team to train the Deep Learning models.

Anticipated Cost: Financial Resources Provided by Client:
Senior Design Project Proposal Form

Preferred Students for the Project:

☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☑ Cyber Security Engineering
☐ Other:

Other Special Skills: Javascript programming skills, Machine Learning/Deep Learning, computer architecture background

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
  ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

On this project, students will need to apply knowledge of mathematics, science, and engineering

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This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddec21-proj018
☐ Project Assigned:
☐ Advisor(s) Assigned:
Senior Design Project Proposal Form

Client/Company/Organization: IAC

Submitter Name: Doug Jacobson Email: dougj@iastate.edu

Project Title: Curriculum to use the Sphero RVR in IT-Adventures.

Project Abstract:
The Information Assurance Center runs a state wide high school outreach program called IT-Adventures (www.it-adventures.org) which is design to increase interest in IT. The program is organized around clubs that learn about robotics, smart-IT and cyber security (venues). The students in the clubs use inquiry based learning where they are given monthly tasks and need to learn certain concepts to complete the tasks. Starting next year we plan to introduce the Sphero RVR as the primary platform to teach robotics and smart-IT. The focus in the robotics will be to use learn programming and how to control the RVR and various sensors. In Smart-IT the RVR will be outfitted with a Raspberry PI and the students will learn about embedded systems and more complex interactions with the physical world.
The goal of the senior design project will to be develop a curriculum for these two venues which will include learning objectives, learning materials, references to outside materials, and hands-on monthly challenges. There will be overlap between the two curricula. This project will also involve the creation of the hands-on exercises to help the students use the RVR. Since COVID may affect the team’s ability to work together we will loan each member of the senior design team and RVR to play with. This will also let the team experiment with how students might be able to have the RVRs interact with other.

Expected Deliverables:
Curriculum to be used by high schools across the state of Iowa

Specialized Resources Provided by Client:
Sphero RVR and Raspberry PI and Sphero little bits

Anticipated Cost: Financial Resources Provided by Client: Funding to supply the RVRs, Pis, and Little Bits

Preferred Students for the Project:
☐ Electrical Engineering
☑ Computer Engineering
☐ Software Engineering
☑ Cyber Security Engineering
☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):
Senior Design Project Proposal Form

☐ 1 meeting per week
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☐ 1 meeting per month
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 2 or more meetings per month
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☐ 1 meeting per semester
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Meeting ABET Criteria

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj019

☐ Project Assigned: 

☐ Advisor(s) Assigned: 

----------------------------------
Project Title: Checker^2

Project Abstract:
We are seeking to use a symbolic execution engine to analyze critical portions R2U2: Realizable Responsive Unobtrusive Unit. R2U2 is a runtime monitor used in a variety of real time safety critical systems in use on systems such as Robonaut 2 onboard the ISS. The project aims to use Klee, a symbolic execution engine in the LLVM tool chain, to thoroughly test the most critical portions of the R2U2 code base, notably the implementations of novel algorithms. In the process of developing a framework for Klee to generate a high test coverage, the aim is to also make improvements to the symbolic execution engine and its usability with non-trivial code.

Expected Deliverables:
- Developed framework used to run Klee over portions of R2U2, such that other non-trivial code can use the same framework.
- Tests generated by the symbolic execution engine over the most critical portions of the R2U2 code base.
- Improvements to the symbolic execution engine (expected improvements may include automating the declaration of symbolic inputs, more automated handling of external libraries, and a GUI implementation).

Specialized Resources Provided by Client:

Anticipated Cost: ______________________ Financial Resources Provided by Client: ________________

Preferred Students for the Project:
☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other: ______________________________________

Other Special Skills: C programming, interest in software testing/static analysis

Anticipated Client Interaction (estimate):
☑ 1 meeting per week
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☑ 1 meeting per month
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Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  
sddec21-proj020

☐ Project Assigned:  

☐ Advisor(s) Assigned:  

________________________________________

________________________________________
Project Title: Open-Source Prototyping of 5G-and-Beyond Wireless Systems

Project Abstract:

As a key milestone in wireless communication, 5G wireless networks are expected to enable not only Gbps mobile connectivity but also machine-type communications for smart agriculture, connected and automated vehicles, smart grid, Industry 4.0, and AR/VR. Besides advanced communication technologies such as ultra-reliable, low-latency communication, 5G wireless networks represent the convergence of computing and networking in many aspects of the telecommunication industry, and they embrace opportunities such as software-defined, open-source innovation and infrastructure virtualization. 5G wireless is projected to reach a market size of $250 billion by 2025, and it has been attracting significant investment from industry and government worldwide.

Through this project, students will learn, develop, and prototype advanced wireless solutions for 5G and beyond. As a part of the project, students will get to “play” with the state-of-the-art platform technologies such as the open-source cellular network implementation platform srsLTE (https://www.srslte.com/), USRP software-defined radios (https://www.ettus.com/), and at-scale field wireless testbeds such as Powder (https://powderwireless.net/), COSMOS (https://www.cosmos-lab.org/), and AERPAW (https://aerpaw.org/).

Students will work as a team and with Prof. Hongwei Zhang and his research team who are experts in advanced wireless systems. Students also have the potential to interact with industry partners such as John Deere, Collins Aerospace, and Ford Research. Information about Prof. Zhang’s work can be found at http://www.ece.iastate.edu/~hongwei/.

Expected Deliverables:

A tentative project roadmap is as follows (which is open for revision by the project team):
* Jan - March 2021: Studying basics of 5G wireless, existing solutions, and open-source platforms; Selecting, studying, and potentially refining an advanced wireless algorithm for 5G and beyond (e.g., for predictable interference control and/or real-time communication);
* April 2021: Implementing the aforementioned wireless algorithm using srsLTE;
* August – November, 2021: Refining and evaluating, in an agile, spiral manner, the algorithm using advanced wireless testbeds such as Powder, COSMOS, and/or AERPAW;
* December, 2021: Demonstration and report

Specialized Resources Provided by Client:

Hardware and software components for advanced wireless systems, algorithms for 5G and beyond

Anticipated Cost: ___________________________ Financial Resources Provided by Client: (e.g., equipment)
Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering
- Software Engineering
- Other Special Skills: Background in wireless/computer networks and software development (with C and/or C++); willingness to learn; teamwork.
- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):

- 1 meeting per week
  - ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
- 1 meeting per month
  - ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
- 2 or more meetings per month
  - ☑ In person, ☐ Over the phone, ☐ Web / video conferencing
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Meeting ABET Criteria

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Project Approval – for use by ECpE Senior Design Committee

- ☑ Approved: sddec21-proj021
- ☐ Project Assigned: __________________________________________
☐ Advisor(s) Assigned: ________________________________

______________________________
Senior Design Project Proposal Form

Client/Company/Organization:  Iowa State University

Submitter Name:  Lotfi Ben Othmane  Email:  othmanel@iastate.edu

Project Contact:  Lotfi Ben Othmane  Email:  othmanel@iastate.edu

Project Title:  Website for sharing knowledge

Project Abstract:
The goal of the project is to develop a web application that experts use to share knowledge about threat modeling patterns. The system uses text mining algorithm to extract information from each of the pattern and save that to a database.

Expected Deliverables:
1- Web application for submitting threat modeling patterns in the form of blogs.
2- Use text-mining system to extract threat modeling information from each of the blogs.
3- Visualize the threat modeling knowledge to experts.

Specialized Resources Provided by Client:
Expertise on cybersecurity and software engineering

Anticipated Cost:  Financial Resources Provided by Client:  NA

Preferred Students for the Project:
☐ Electrical Engineering  ☑ Computer Engineering
☑ Software Engineering  ☑ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):
☑ 1 meeting per week
   ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
   ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria
Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj022
☐ Project Assigned: 
☐ Advisor(s) Assigned: 
**Client/Company/Organization:** Danfoss Power Solutions

**Submitter Name:** Mohamed Eldakrouy  
**Email:** meldakrouy@danfoss.com

**Project Contact:** Mohamed Eldakrouy  
**Email:** meldakrouy@danfoss.com

**Project Title:**  
Automatic Detection of Paint Defects using Deep Learning

**Project Abstract:**  
At Danfoss, the rate of defective pumps due to bad paint quality has been high for the past few years. Defective units most often occur in consecutive batches. Detecting the first unit(s) in a defective batch of pumps is a key to stopping operation and fixing the paint robot before further occurrences happen. The goal of this project is to use a vision system and deep learning to detect defective units early on the line and to prevent further occurrences. The data set of defective units images will be provided by Danfoss for model training.

**Expected Deliverables:**
1. A software to detect defective units based on product images.
2. A tracking system to track serial numbers of defective units.
3. Hardware/ software integration to automatically capture images and save them.

**Specialized Resources Provided by Client:**
1. Hardware including camera, lighting and all needed hardware
2. Dataset of images for model training.
3. Process Engineering and Process Technicians support

**Anticipated Cost:**  
**Financial Resources Provided by Client:** 5000

**Preferred Students for the Project:**
- ☑ Electrical Engineering
- ☑ Computer Engineering
- ☑ Software Engineering
- ☐ Cyber Security Engineering
- ☐ Other:

**Other Special Skills:** Machine Learning

**Anticipated Client Interaction (estimate):**
- ☑ 2 or more meetings per month  
  ☑ In person, ☑ Over the phone, ☑ Web / video conferencing
- ☑ 1 meeting per semester  
  ☑ In person, ☑ Over the phone, ☑ Web / video conferencing
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

- 0 – Not at all
- 1 – A Little
- 2 – Somewhat
- 3 – A Lot
- 4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddec21-proj023

☐ Project Assigned:

☐ Advisor(s) Assigned:
Project Title:
Plugins-based framework for fleet management analytics

Project Abstract:
The goal of this project is to develop a framework that supports dynamic inclusion of data analytics plugins into a fleet management systems. Each of the plugins can process the fleet management data and visualizes the results on the dashboard.

Expected Deliverables:
1- A data analytics application for predicting fuel usage for a fleet of cars
2- A plugins framework that operates dynamically deliverable 1. The framework will use a set of configuration files that plugins should use to be called dynamically by the framework
3- Mechanisms for controlling access of the plugins to the data.

Specialized Resources Provided by Client:
a fleet management application and devices that would be used in the project.

Anticipated Cost: Financial Resources Provided by Client:

Preferred Students for the Project:
- Electrical Engineering
- Computer Engineering
- Software Engineering
- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):
- 1 meeting per week
  - In person, Over the phone, Web / video conferencing
- 1 meeting per month
  - In person, Over the phone, Web / video conferencing
- 2 or more meetings per month
  - In person, Over the phone, Web / video conferencing
- 1 meeting per semester
  - In person, Over the phone, Web / video conferencing

Meeting ABET Criteria
Please rate the following statements as they relate to your proposed project:

- On this project, students will need to apply knowledge of mathematics, science, and engineering

- This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

- This project involves students from a variety of programs, i.e., CprE, EE, and SE

- This project requires students to identify, formulate, and solve engineering problems

- This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj024

☐ Project Assigned:

☐ Advisor(s) Assigned:
Project Title: Interactive, Batteryless Handheld Game

Project Abstract:

Your mission, if you choose to accept it, is to develop an interactive, multi-player hand-held game solely powered by energy-harvesting. Specifically, the harvested energy could come from human vibration and button presses, requiring direct physical exertion to power the game -- no more using your phone's battery to till a field or chuck some birds. Consider a Digimon that no longer dies; a Tamagotchi that helps you get exercise; enhanced DDR-judging gloves; an intermittent lightsaber; essentially this project is your senior design oyster!

I expect solid game-play with a quirky story for marketing. There must be interaction between at least two devices (one per competitor), although the more the better. Given the nature of this project it will almost certainly require diverse skills from software development to hardware engineering to intensive user studies (target users: ECpE faculty).

Expected Deliverables:

* PCB-based prototype of game that can demonstrate interactive play
* Well-documented software repository with plenty of ECpE-related easter eggs
* Well-documented hardware repository of PCB design files in KiCAD

Specialized Resources Provided by Client:

* A range of MCU and wireless sensor boards available in my lab

Anticipated Cost: _______________ Financial Resources Provided by Client: _______________

Preferred Students for the Project:

☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other: Other Special Skills: * An open, creative mind
* At least one student with PCB-creation skills
* Networking/sensor networks/embedded systems skills a plus

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

<table>
<thead>
<tr>
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</table>

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj025
☐ Project Assigned: ____________________________
☐ Advisor(s) Assigned: ____________________________
Project Title: RISC-V SoC Hardware Vulnerability Detection Toolset

Project Abstract:
Increasingly our pervasive technology is being dominated by system on chips (SoCs). Unfortunately, the increasing complexity of such designs makes removing hardware bugs and security vulnerabilities especially challenging. The goal of this project is to construct a tool set framework that can be used for hardware capture-the-flag competitions such as https://hackathard.com/hacksec21/. Students will be encouraged to use an agile approach to the development of the tool set based on publicly-available buggy SoC designs (e.g., https://github.com/gdessouky/hackdac_2018_beta) as well as participation in a hardware capture-the-flag competition.

Expected Deliverables:
* Documented, extensible toolset that can be used to generically search for security vulnerabilities in a SoC design
* List of bugs and exploits detected from an unseen, buggy RISC-V SoC

Specialized Resources Provided by Client:

Anticipated Cost: ___________________________ Financial Resources Provided by Client: ___________________________

Preferred Students for the Project:
☐ Electrical Engineering
✓ Computer Engineering
✓ Software Engineering
✓ Cyber Security Engineering
☐ Other:

Other Special Skills: * Prior experience with security competitions a plus
* Some digital design experience required

Anticipated Client Interaction (estimate):
✓ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0  ☑ 1  ☑ 2  ☑ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

☐ 0  ☑ 1  ☑ 2  ☑ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☑ 1  ☑ 2  ☑ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☑ 1  ☑ 2  ☑ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☑ 1  ☑ 2  ☑ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddec21-proj026
☐ Project Assigned:  ________________________________
☐ Advisor(s) Assigned:  ________________________________
Project Title: Canvas LTI Student Climate Dashboard

Project Abstract:
When running a medium to large course, it can be very challenging to keep track of the general student sentiment. This is especially true for virtual offerings with less interpersonal interaction. However, student feeling/sentiment will be automatically collected with each course assignment, big or small. Coupled with other available data available from within existing assignments, an on-going journey map of students will be automatically constructed and displayed as a dashboard with a set of visualization tools to allow instructors to root cause pain points and proactively identify students beginning to disengage from the course even while they are still attending and submitting work.

Expected Deliverables:
* Canvas Learning Tool Integration (LTI) dashboard showing student climate statistics
* written justification that appropriate software engineering practices used to preserve sensitive student data

Specialized Resources Provided by Client:

Anticipated Cost: ___________________ Financial Resources Provided by Client: ___________________

Preferred Students for the Project:

☐ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering

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☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  

sddec21-proj027

☐ Project Assigned:

☐ Advisor(s) Assigned:
Project Title: Development of IoT Components for CDC (Cyber Defense Competition)

Project Abstract:

The goal of this project is to integrate IoT components into ISEAGE and CDC (Cyber Defense Competition). Examples of IoT devices include webcams, smart plugs, smart locks, smart meters, programmable thermostats, and more.

1. This project is Phase 2 of the IoT-CDC effort. The senior design team will work closely with a current senior design team sdmay2128 (Phase 1) and a couple of graduate students.

2. Students are expected to study and understand how ISEAGE and CDC work.

3. The developed IoT components shall include physical IoT devices. We are particularly interested in IoT devices with known security vulnerabilities.

4. The developed IoT components shall be able to emulate a large number of virtual IoT devices, thus making it scalable. To do so, students are expected to study the physical IoT devices, understand their architectures and operating systems, and then create virtual IoT devices, which will used to provide realistic emulation of the physical IoT devices.

5. Students are expected to identify and demonstrate attack and defense strategies against the developed IoT components.

Expected Deliverables:

- Integration and demonstration of at least one type of IoT devices into ISEAGE/CDC by May 2021.
- Integration and demonstration of an additional type of IoT devices into ISEAGE/CDC by December 2021.
- Proper documentation and user manual for the developed IoT components and IoT-CDCs.

Specialized Resources Provided by Client:

ISEAGE environment, and funds to acquire physical IoT devices.

Anticipated Cost: 
Financial Resources Provided by Client: 

Preferred Students for the Project:

☐ Electrical Engineering
☐ Computer Engineering
☐ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: 3~5 Cpr E or S E or Cyber E students with the following skills: knowledge and programming skills with networking, operating system, and cyber security; embedded systems and programming. Past experience with ISEAGE and CDC is a plus.
Senior Design Project Proposal Form

Anticipated Client Interaction (estimate):

☐ 1 meeting per week
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 2 or more meetings per month
  ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sdddec21-proj028

☐ Project Assigned:  

☐ Advisor(s) Assigned:  

☐
Project Title: IDS-ICS: Intrusion Detection System for Industrial Control Systems

Project Abstract:
Intrusion Detection System (IDS) for Industrial Control System (ICS) is an emerging area of R&D effort and significant industry need in recent years. This project focuses on the design, implementation, testing, and evaluation of an IDS for two protocols (Modbus and DNP3). The IDS environment includes multiple IDS Clients/Sensors (at least two), implemented on NI CRIO platform (with LabView), communicating to an IDS Master running on a cloud infrastructure (e.g., AWS). The IDS software environment to be used in the project is SecurityOnion SIEM tool. The IDS Client will implement IDS rules (for the given protocols) and the IDS Master will implement visualization and security analytics. Basic rules for Modbus IDS and DNP3 IDS will be provided, and the SecurityOnion tool provides a rich set of visualization and analytics. The project is expected to accomplish the following: (1) Demonstration of IDS Client-Server implementation (client implementation, server implementation, and establishing connectivity between them), and (2) Testing of Client-Server IDS environment for functional and interoperability testing, and security evaluation of the IDS for detection accuracy (false positive/false negative rates).

Expected Deliverables:

SYSTEM SETUP:
1) Install NI CRIO Kit hardware and do administration tasks; 2) Install a Modbus Client on the NI Kit; 3) Install a HMI Application to test Modbus; 4) Install Docker to the Kit; 5) Build Containers on the Kit; 6) Connect built containers to outside systems.

DESIGN & IMPLEMENTATION:
7) Install SNORT IDS on the kit; 8) Update SNORT Rules and configurations; 9) Add Modbus and DNP3 rules and configurations; 10) Integration with IDS Master (SecurityOnion); 11) Send alerts to remote IDS Master (running inside AWS Cloud); 12) Encrypt alerts traffic from SNORT Sensors to the SecurityOnion Master (cloud); 13) Format & Visualize Alerts on SecurityOnion IDS Master.

TESTING & EVALUATION:
14) Conduct functional testing, interoperability testing, and end-to-end testing;
15) Conduct experimental evaluation for sample (stealthy) attack scenarios to evaluate the detection accuracy of IDS Sensors;
16) Show a couple of sample alert correlation analytics at the IDS Master.

Specialized Resources Provided by Client:
SecurityOnion SIEM environment, NI CRIO platform, AWS cloud, Docker container, Base IDS rules for Modbus and DNP3 protocols. Technical discussion/consultation by graduate students.

Anticipated Cost: 2000

Preferred Students for the Project:
Electrical Engineering

Other Special Skills: Desired skills in familiarity to one or more
Senior Design Project Proposal Form

☑ Computer Engineering
☑ Software Engineering
☑ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj029
☐ Project Assigned: ____________________________________________
☐ Advisor(s) Assigned: _________________________________________
Senior Design Project Proposal Form
Senior Design Project Proposal Form

Client/Company/Organization: Doug Jacobson & Julie Rursch

Submitter Name: Julie Rursch
Email: jrursch@iastate.edu

Project Title: ISEAGE Traffic Generator

Project Abstract:
ISEAGE is used to support several courses including 230, 231, 331, 430/530, 532, 632. There is a need in many of these classes to generate background traffic. The types of traffic that are needed to be generated are:
- Normal TCP/IP traffic representing a variety of different applications;
- Attack traffic based off of known signatures;
- Control / messaging traffic (ARP, IMCP, etc).

The requirements of the traffic generator are:
- Programmable (fixed or random) source and destination addresses.
- Programmable data rates
- Programmable packet types
- Realistic payload for applications. For applications the traffic generator can communicate with various servers to provide the realistic payload
- Integrated into the ISEAGE environment.
- Attack traffic can be programmed into the generator, with a possible extension of reading the SNORT database to create traffic that matches the signatures

Expected Deliverables:
A working prototype to generate traffic

Specialized Resources Provided by Client:
Access to an ISEAGE environment.

Anticipated Cost: 
Financial Resources Provided by Client: 

Preferred Students for the Project:

☑ Electrical Engineering
☑ Computer Engineering
☐ Software Engineering
☑ Cyber Security Engineering
☐ Other:

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  
1 – A Little  
2 – Somewhat  
3 – A Lot  
4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☑ 3  ☐ 4

Project Approval – for use by ECpE Senior Design Committee

☑  Approved:  sddec21-proj030  
☐  Project Assigned:  
☐  Advisor(s) Assigned:  

☑  1 meeting per month
☐  In person, ☐ Over the phone, ☑ Web / video conferencing
☐  2 or more meetings per month
☐  In person, ☐ Over the phone, ☑ Web / video conferencing
☑  1 meeting per semester
☐  In person, ☐ Over the phone, ☑ Web / video conferencing
Virtualizing IoT for use in ISEAGE/ISELab

Project Abstract:

The Internet of Things (IoT) has exploded on the world, both in consumer and commercial products. One estimate claims there will be 50 billion IoT devices in service as of the end of 2021 and that number is projected to grow to 65 billion in 2025. Many consumer products sold today are connected to home networks, include sensor and actuators, and transmit their data to a remote location to be analyzed. And, while IoT provides home automation and simplicity of management, IoT provides many challenges to cybersecurity.

Unfortunately, it has been difficult to create a lab situation to allow students to work with IoT devices connected into a highly virtualized testbed such as ISEAGE/ISELab. This senior design project is to develop virtualized IoT devices that can be deployed into the ISEAGE environment. These software defined IoT devices will differ from a traditional deployment of IoT devices which need to be “plugged into” the ISEAGE environment. The IoT devices themselves, as well as their core functions and controlling applications, will be virtual images that can be replicated and deployed to students.

The current project is conceptualized as an automated home that uses completely virtualized devices and communication.

The requirements are

1. Software defined IoT devices – devices that have been virtualized and no longer are a physical object that need connected into ISEAGE
2. Software defined core functions that are normally found in IoT devices.
3. Control and communication functions for the newly created software defined IoT devices that work within the ISEAGE environment. This would include traditional wireless communication from the IoT device to the controlling database needing to use the wired ISEAGE network.
4. Ability to implement security / remove security in the software defined IoT device which could be included in an introductory cyber security course such as 230 or 231.
5. Curricular materials developed for inclusion into the introductory cyber security course.

Expected Deliverables:

Working prototype virtualized IoT home automation network in ISEAGE/ISELab

Specialized Resources Provided by Client:

Access to ISEAGE/ISELab testbed
**Senior Design Project Proposal Form**

**Anticipated Cost:** ________________  **Financial Resources Provided by Client:** ________________

**Preferred Students for the Project:**
- [ ] Electrical Engineering
- [☑] Computer Engineering
- [ ] Software Engineering
- [☑] Cyber Security Engineering
- [ ] Other:

**Other Special Skills:**

**Anticipated Client Interaction (estimate):**
- [ ] 1 meeting per week
  - [ ] In person, [ ] Over the phone, [ ] Web / video conferencing
- [☑] 1 meeting per month
  - [ ] In person, [ ] Over the phone, [☑] Web / video conferencing
- [ ] 2 or more meetings per month
  - [ ] In person, [ ] Over the phone, [ ] Web / video conferencing
- [ ] 1 meeting per semester
  - [ ] In person, [ ] Over the phone, [ ] Web / video conferencing

**Meeting ABET Criteria**

Please rate the following statements as they relate to your proposed project:

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<th>3 – A Lot</th>
<th>4 – Completely</th>
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</table>

On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0  ☐ 1  ☐ 2  ☐ 3  [☑] 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

☐ 0  ☐ 1  ☐ 2  ☐ 3  [☑] 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☐ 1  ☐ 2  [☑] 3  ☐ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☐ 1  ☐ 2  ☐ 3  [☑] 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  [☑] 4

**Project Approval – for use by ECpE Senior Design Committee**

[☑] Approved:  
sddec21-proj031

[ ] Project Assigned:  

______________________________
☐ Advisor(s) Assigned: ________________________________

____________________________________
Project Title: IoT-SmartLights: Remotely Controlled Advanced IoT Smart Lights Hub Prototype

Project Abstract:
This project is an extension to the “Dec19-16: Wireless-enabled Smart-Lights Hub Prototype” (http://seniord.ece.iastate.edu/projects/dec2019.html). This project aims to design and implement Zigbee-based IoT smart lights and IoT Zigbee gateways and integrate them with web-based applications in a cloud environment for configuration and management. We will use ISU’s PowerCyber Cloud platform and the Dec19-16 project resources for the design and implementation. Students will receive all the required materials, including hardware/software resources of Dec19-16, for working on these platforms. Web-based programming experience and Embedded systems (Raspberry-PI, Zigbee) are the essential prerequisites. At the end of the project, you will learn cloud computing, IoT sensors (edge-computing), web-based application services, and the power grid. This project includes the following modules to be developed: 1) Reinvestigation on the Zigbee-based smart lights PCB design of the Dec19-16 project and build and implement them for flexible and scalable prototypes. 2) Use the existing IoT gateways of Dec19-16 and modify them to integrate IoT sensors and cloud-based web applications. 3) Design and implement cloud-hosted web-based dashboards to configure and manage the Zigbee-based IoT smart lights and visualize data analytics. 4) Test and validate the applications with available power grid simulators such as OPAL-RT.

Expected Deliverables:
1) Software codes for Zigbee-based IoT smart lights, IoT gateway, cloud-based web applications, 2) Zigbee-based IoT smart light and gateway hardware, and 3) Technical project report.

Specialized Resources Provided by Client:
Access to PowerCyber Lab, Hardware/software units required to the prototype, and access to final deployment VM.

Anticipated Cost: Financial Resources Provided by Client: Yes

Preferred Students for the Project:
- Electrical Engineering
- Computer Engineering
- Software Engineering
- Other Special Skills: PCB design, embedded systems, and Web-based front-end/back-end programming
- Cyber Security Engineering
- Other:

Anticipated Client Interaction (estimate):
- 1 meeting per week
  - In person, ☐ Over the phone, ☑ Web / video conferencing
Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0 □ 1 □ 2 □ 3 ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0 □ 1 □ 2 □ 3 ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0 □ 1 □ 2 □ 3 ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0 □ 1 □ 2 ☑ 3 □ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0 □ 1 □ 2 □ 3 ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj032
❑ Project Assigned: ________________________________
❑ Advisor(s) Assigned: ________________________________
Project Title: IIoT-Grid: Cloud-Integrated Industrial Internet of Things for Power Grid

Project Abstract:

The Industrial Internet of Things (IIoT) is an evolution of a distributed control system (DCS) that allows for a higher degree of automation by using cloud computing to refine and optimize the process controls. This project aims to design and implement IIoT sensors and gateways and integrate them with web-based applications in a cloud environment. The IIoT sensor will interact with the power grid simulator using Modbus protocol and send/receive data with cloud-based applications via the IIoT gateways using MQTT and DNP3 protocols over the internet. We will use ISU’s PowerCyber Cloud platform and Google Cloud Platform (GCP) resources for the design and implementation. Students will receive all the required materials for working on these platforms. Programming experience, Linux working environment, Embedded systems (Raspberry-PI, Zigbee, Lora) are the essential prerequisites. At the end of the project, you will learn cloud computing architecture, IIoT sensors (edge-computing), web-based application services, power grid, and attain hands-on experience with the GCP resources. This project includes the following modules to be developed: 1) Design and implementation of IIoT sensor using both hardware and virtual platforms and connect them with power grid simulator and IIoT gateways, 2) Design and implementation of IIoT gateways and connect them with IIoT sensors and cloud-based web applications, 3) Design and implementation of cloud-hosted web-based dashboards to visualize the grid data from IIoT sensors and IIoT gateways on geographical maps, plots, and analytics, and 4) Test and validate the applications with available power grid simulators such as OPAL-RT and GridAPPS-D.

Expected Deliverables:

1) Software codes for IIoT sensor, IIoT gateway, cloud-based web applications, 2) IIoT sensor and gateway hardware, and 3) Technical project report.

Specialized Resources Provided by Client:

PowerCyber VMs, Required embedded hardware, Google Cloud Platform (GCP) resources, and GCP Course Material.

Anticipated Cost: Financial Resources Provided by Client: Yes, GCP resources and embedded hardware as required.

Preferred Students for the Project:

- Electrical Engineering
- Computer Engineering

Other Special Skills: Embedded systems, and Web-based front-end/back-end programing
Senior Design Project Proposal Form

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
  ☐ In person, ☑ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddec21-proj033
☐ Project Assigned:  
☐ Advisor(s) Assigned:  
Project Title: Counterfeit Countermeasures for the Integrated Circuit Supply Chain

Project Abstract:

This project will focus on the development of a counterfeit countermeasure strategy for integrated circuits. There are varying estimates about the number of counterfeit electronic components that are in the standard component supply chain today. According to a recent Scientific American article, the US government estimates that up to 15% of the components in their inventory for spare and replacement use are counterfeit. Other estimates place the total counterfeit market at between 1% and 2% of total semiconductor sales. Regardless, counterfeiting of integrated circuits is now a multi-billion dollar business. Counterfeit parts are extremely difficult to detect since the counterfeiters go to extreme measures to make the counterfeit parts look and act as if they are authentic. Though the counterfeit market detracts from the market potential from legitimate manufacturers such as Intel, Samsung, Texas Instruments, ... the major concern is the degraded reliability associated with counterfeit parts since there are no known ways to predictably and nondestructively assess reliability of individual components.

In this project, a PUF (physically unclonable function) -based authentication circuit will be designed that can be embedded in any integrated circuit by the manufacturer. The authentication circuit will contain a unique code and when a customer receives a part, they will be able to check with the manufacturer to see if the code in their part agrees with the unique code of the manufacturer. To make the authentication circuit attractive to both the semiconductor manufacturers, it must be extremely small, require no additional pins, and have no adverse effect on performance of the desired circuit during normal operations. The client will describe a way this can be achieved.

Though this project focuses on using PUFs for authentication of integrated circuits, PUF-based verification is an area of growing interest for secure transactions and secure communications and should have applications well beyond the counterfeit countermeasure area.

This project will include the development of a cloud-referenced data management plan that can be used to interact between the manufacturer and the consumer. Though at this stage there will be no attempt to limit the creativity of the team in coming up with a solution, some have suggested using a Block Chain approach. When fully implemented, it should be able to keep track of enough integrated circuits so that the financial incentive to the counterfeiters is removed. In the initial stages where there are a large number of counterfeiters, it may be necessary to keep track of most integrated circuits but as financial incentives are removed from the counterfeiters, it may only be necessary to keep track of a small portion of the parts to prevent a resurgence of counterfeiters.

Expected Deliverables:

Study and report on characteristics of existing weak and strong PUFs. Prototype design of a PUF-based authentication circuit that can be used for anti-counterfeit authentication. Hopefully this circuit can be designed so that it can be fabricated and tested during the second semester. Another deliverable will be the design of a cloud-referenced data management plan that is capable of tracking a large number of integrated circuits.

Specialized Resources Provided by Client:

None
Senior Design Project Proposal Form

Anticipated Cost: ___________________________  Financial Resources Provided by Client: None needed

Preferred Students for the Project:
☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☑ Cyber Security Engineering
☐ Other:

Other Special Skills: Students working on hardware component of project should have taken or be enrolled in EE 330

Anticipated Client Interaction (estimate):
☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

0 – Not at all  1 – A Little  2 – Somewhat  3 – A Lot  4 – Completely

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj034
☐ Project Assigned: ___________________________________________________________________________

☑ Project Assigned: ___________________________________________________________________________
☐ Advisor(s) Assigned: ____________________________________________

________________________________________________________
Project Title: Compact Low Power Temperature Sensors for Power/Thermal Management

Project Abstract:

There is a highly nonlinear relationship between lifetime of an integrated circuit and the power and thermal stress. At low temperatures and low current levels, the average lifetime of an integrated circuit is very long but at higher temperatures and higher current levels, the average lifetime of an integrated circuit can become unacceptably short. This is particularly a problem in components used in servers and a host of consumer applications where high clock frequencies are desired to increase performance. To maintain favorable tradeoffs between performance and lifetime, a large number of very small temperature sensors are placed on a die to locally monitor temperature. Throttling is then used to reduce the clock frequency and correspondingly limit the temperature to an acceptable level. This project will focus on the design of very compact temperature sensors that can be widely distributed across a die. The threshold voltage of MOS transistors is highly temperature dependent as is the I-V relationship in a pn junction and either can be used to sense temperature. Combining the benefits of both types of temperature sensors offers potential for obtaining a more optimal solution than can be obtained with either type by itself. Students working on this project will interact with a group of graduate students that are working on the same project which is supported by the Semiconductor Research Corporation. Liaisons from several major semiconductor companies will provide feedback and guidance on the project. The goal will be to design and test very compact integrated temperature sensors that have the accuracy needed to accurately control the reliability of large integrated circuits.

Expected Deliverables:

There are 4 deliverables. The first is an assessment of the performance capabilities and limitations of existing integrated temperature sensors that have been reported in the literature. The second will be the development of a strategy for practically designing compact temperature sensor arrays. The third will involve the design of an integrated temperature sensor array, likely in a 65nm CMOS process. The fourth will be testing the performance of the integrated temperature array.

Specialized Resources Provided by Client:

None Required

Anticipated Cost: ☑

Financial Resources Provided by Client: ☐

Preferred Students for the Project:

☐ Electrical Engineering
☐ Computer Engineering
☐ Software Engineering
☐ Cyber Security Engineering
☐ Other: Other Special Skills: At a minimum, students should be registered in EE 330, preferably completed EE 330. Enrollment in or completion of EE 435 would be a benefit.
Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

<table>
<thead>
<tr>
<th>0 – Not at all</th>
<th>1 – A Little</th>
<th>2 – Somewhat</th>
<th>3 – A Lot</th>
<th>4 – Completely</th>
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On this project, students will need to apply knowledge of mathematics, science, and engineering ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project requires students to identify, formulate, and solve engineering problems ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj035
☐ Project Assigned: _____________________________
☐ Advisor(s) Assigned: ___________________________
Senior Design Project Proposal Form

Project Title: High Resolution Trimmable Resistor

Project Abstract:

The goal on this project is to develop a good high-resolution digitally trimmable resistor. The digitally trimmable resistor is comprised only of switches and resistors with the switches controlled by a logic circuit. The resistor is to be trimmed by opening or closing switches controlled by an n-bit Boolean input. Ideally the switches should act as a short circuit when on and an open circuit when off but practically the switches will have an on impedance of RSW. The trim range should be small with the goal of changing the resistor value from RN to RN(1+θ) or to RN(1-θ) where θ is small. By small, think of the value of θ being around 0.01. Ideally there would be 2n uniformly spaced increments in the resistance in the range RN<R< RN(1+θ). Useful values of n would be from 2 to 6. An acceptable less-demanding solution would relax the uniform spacing requirements.

There are numerous applications throughout the semiconductor industry for high resolution digitally trimmable resistors. The demands for these devices will increase as expectations for higher levels of performance of electronic systems continues to grow.

There are three constraints on this design and therein lies the challenge. The first constraint is that the total value of all of the resistors relative to RN should not be too big. The second constraint is the size of all of the switches characterized by the sum of the ON conductances should not be too large relative to the conductance of RN. The third constraint is that the temperature dependence of the trimmed resistor should be small.

This is a research project that requires a background in circuits at probably week 4 in EE 201. Good results should be publishable in the technical literature, will likely be patentable, and likely will generate quite bit of interest in industry.

Now a bit of background. There are two common methods that have been known for at least 50 years for solving this problem and both are widely used today. Unfortunately neither is near optimal. One, termed the standard series solution, is comprised of n small resistors in series with RN where each resistor is placed in parallel with a switch. The resistors are weighted RX, RX/2, RX/4, ... RX/2n-1 and the sum of the switching resistors is approximately θ RN. For the standard series solution, the conductance of the switches must be large relative to RX, RX/2, ... RX/2n-1. The second is termed the standard parallel solution and is comprised on n large resistors in series with a switch placed in parallel with RN. The resistors are RY, 2RY, 4RY, ... 2n-1 RY and the parallel combination of all of the resistors is approximately RN/θ. For the standard parallel solution, the value for the switched resistors are large.

The major limitation of the standard series solution is the large conductance of the switches since switches with a large conductance are physically large. This does not satisfy the second constraint. The major limitation with the standard parallel solution is the size of the parallel resistors which are physically large. This does not satisfy the first constraint.

As a research project, a study of solutions that have been proposed and that appear in the literature would first be made. This would be followed by an investigation of circuit structures that offer improvements over the state of the art. Likely there is no optimal solution to this problem so the project would focus on heuristic solutions. Algorithm development, computer simulations, optimization, and creativity would comprise the major focus on this project. Though this may appear to be an electrical engineering project and electrical engineering students should be able to
Senior Design Project Proposal Form

contribute, the electrical engineering component is at the beginning EE 201 level. Team members with a background in software engineering or computer engineering should have the technical background necessary to play a lead role on this project. Though two examples were described above, Professor Geiger can provide guidance on how to formulate the problem and provide suggestions of alternative solutions that may lead to improvements on the state of the art.

Expected Deliverables:

Report on existing approaches for building digitally trimmable resistors. Design of new trimmable resistor structures in 0.5um CMOS process supported by layout and simulation results. Comparison of new trimmable resistors with existing approaches focusing on area, trim resolution, and temperature dependence.

Specialized Resources Provided by Client:

Anticipated Cost: __________________________ Financial Resources Provided by Client: __________________________

Preferred Students for the Project:

☑ Electrical Engineering
☑ Computer Engineering
☐ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: Solid background in EE 201. At least 1 team member should have completed EE 330.

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4
Senior Design Project Proposal Form

safety, manufacturability, and sustainability

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved:  sddec21-proj036

☐ Project Assigned:

☐ Advisor(s) Assigned:

__________________________________________

__________________________________________
Project Title: Multi-State Trojans: A Threat to Hardware Security

Project Abstract:
Hardware Security is critical to achieving Cyber Security. Most recognized threats to hardware security are associated with the malicious modification of hardware which typically involves adding hardware to a system by a rogue engineer that will alter the performance of the system. There is considerable ongoing work on trying to detect these circuit modifications to thwart the bad actors. This detection problem is challenging if the system is large but existing approaches create a significant barrier to rogue engineers.

Another hardware security concern, identified by researchers at Iowa State University, is associated with embedding a Trojan as undesired operating points of a circuit that can be triggered by an adversary. These Trojans are termed PAAST Trojans because they are power, area and architecture transparent. That is, they require no circuit modifications and will escape detection with all known hardware detection tools. Cover for these Trojans is provided by an open problem in the mathematics/computer science community – that being that there are no known methods for obtaining all solutions of a set of nonlinear differential equations. As such, PAAST Trojans can be embedded in a circuit or system and remain undetectable even if a complete and accurate disclosure of the entire circuit is available. These Trojan modes can be associated with multiple stationary operating points or undesired stationary modes of oscillation.

In this project, examples of circuits that can harbor these Trojans will be given to the design team. The project will involve determining ways to detect the presence of these undesired modes of operation. The team will also focus on identifying specific applications that are particularly vulnerable to PAAST Trojans and on assessing the relative risks of PAAST Trojans compared to those of other hardware Trojans.

Expected Deliverables:
Strategies that might be useful for detecting the presence of PAAST Trojans – preferably those associated with stationary dynamic modes of operation. Report on relative risks associated with PAAST Trojans compared to those of other hardware Trojans.

Specialized Resources Provided by Client:

Anticipated Cost: Financial Resources Provided by Client: 

Preferred Students for the Project:
- [✓] Electrical Engineering
- [☐] Computer Engineering
- [✓] Software Engineering
- [✓] Cyber Security Engineering
- [☐] Other: Other Special Skills: Strong background in linear and nonlinear systems – preferably students focusing on the controls area. Good background in mathematics beyond standard calculus courses would be valuable. Interests in cyber security in general and hardware security in particular would be useful. Ability to
Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

On this project, students will need to apply knowledge of mathematics, science, and engineering
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
☐ 0 ☑ 1 ☐ 2 ☐ 3 ☐ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj037
☐ Project Assigned: ________________________________
☐ Advisor(s) Assigned: ________________________________
Project Title:  
Transferring Global Knowledge to Local Actions

Project Abstract:

Many applications related to smart city and smart agriculture rely on the "journey" of consisting of several stages: gathering large data volumes from individual (sensing) devices -> transmitting the individual data to large-scale storage (e.g., cloud or distributed database) -> analyzing the complete/aggregated data and determining various clustering/classification structures -> generating knowledge/decisions which, in turn, may cause a "push-back" to change the regime of devices. Often times, a change in the values detected in one device may change the operational behavior of other devices. For example: in a smart building, temperature measurement in one apartment may cause the heating to be increased (or decreased) in another; in health application, a change in a signal from blood pressure sensor may demand an increase sampling frequency of the temperature sensor (or other biomarker sensor); in smart agriculture, increased values from temperature sensors may necessitate more frequent samplings from salinity sensors; etc. The main objective of this project is to develop an end-to-end system that will provide enabling solution for a broad range of such applications. Specifically, the system will have (at least) two different types of sensors that will transmit their readings to a server; based on the data AND pre-defined policies, upon receiving of new readings the server may trigger a change in the measurements in one (or both) type(s) of sensors. In addition, the users will have both mobile and web app to interact with the system in the sense of: (1) providing summary of the measurements (with visualization); (2) providing notifications for occurrences of (pre-defined) events; (3) allowing users to change the policies (and/or specific threshold values).

Expected Deliverables:

The major milestones are as follows:
Feb. 10: finalizing the scope of the project;
Feb. 24: completing the literature and the technology overview and define use-case scenario(s);
Mar. 10: draft of the system architecture and preliminary design;
Mar. 24: finalizing the selection of technology/platforms and components;
Apr. 7: finalizing the design and identifying requirements details;
Apr. 21: finalizing the identification of test-cases, development plan and the overall design document and presentation;
Apr. 27: presentation and design document;
Aug. 30: Re-assessing the design;
Sep. 13: Complete the purchase of sensors and UI design;
Sep. 27: Finalize the design of the data management;
Oct. 11: Alpha version of communication between the sensors, server and the app;
Oct. 25: Start individual/component tests;
Nov. 8: Integration testing and Beta version;
Nov. 15: Finalize the demo-scenario and the poster;
Nov. 29: Finalize the report document;
Dec. 6: Presentation and demo; upload the final version of the code on github.
Senior Design Project Proposal Form

Specialized Resources Provided by Client:

Anticipated Cost: __________________________ Financial Resources Provided by Client: __________________________

Preferred Students for the Project:
☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):
☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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On this project, students will need to apply knowledge of mathematics, science, and engineering

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project involves students from a variety of programs, i.e., CprE, EE, and SE

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project requires students to identify, formulate, and solve engineering problems

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☑ 4
☑ Approved: sddec21-proj038

☐ Project Assigned:

☐ Advisor(s) Assigned:

Senior Design Project Proposal Form

Project Approval – for use by ECpE Senior Design Committee
Project Title: Empathy-Aware Telehealth

Project Abstract:

Recently, telemedicine has been used more and more as a paradigm of interaction between patients and physicians. In addition, various telehealth applications have been developed to monitor and assess the vital signs of patients (e.g., upon release from a hospital) for a prolonged period of time. Typically, the manner of using a telehealth app amounts to: (a) recording signals from bodily sensors on a patient; (b) having patients complete pre-defined surveys and/or enter text describing their physical well-being; as well as reporting on activities from a daily regimen (e.g., completing a walk). However, often time, a critical component of the patients recovery is the emotional well-being, for which a typical physician (and a typical app) are not well suited for detection. Similar scenarios occur in working environment, where the emotional/sensory well-being of a team-member may affect both his/her productivity, as well as the entire team. The purpose of this project is to develop an app that will enable detecting changes in a "typical emotional level" of response for the participants (e.g., patient, employee, etc.). More specifically, the app should enable detection of changes in speed of typing, and changes in the voice-pitch (for verbal reports/communication). The main deliverable of the project should be an end-to-end system that will consist of a mobile and web app, along with a server that will store regular patterns and trigger detection of changes.

Expected Deliverables:

Following are the major milestones:
Feb. 10: finalizing the scope of the project;
Feb. 24: completing the literature and the technology overview and define use-case scenario(s);
Mar. 10: draft of the system architecture and preliminary design;
Mar. 24: finalizing the selection of technology/platforms and components;
Apr. 7: finalizing the design and identifying requirements details;
Apr. 21: finalizing the identification of test-cases, development plan and the overall design document and presentation;
Apr. 27: presentation and design document;
Aug. 30: Re-assessing the design;
Sep. 13: Complete the UI design (components);
Sep. 27: Finalize the design of the data management/server component;
Oct. 11: Alpha version of the system;
Oct. 25: Complete unit testing and debugging;
Nov. 8: Integration testing and Beta version;
Nov. 15: Finalize the demo-scenario and the poster;
Nov. 29: Finalize the report document;
Dec. 6: Presentation and demo; upload the final version of the code on github.

Specialized Resources Provided by Client:
Senior Design Project Proposal Form

Anticipated Cost: ______________________  Financial Resources Provided by Client: ______________________

Preferred Students for the Project:

☐ Electrical Engineering  ☑ Computer Engineering  ☑ Software Engineering  ☑ Cyber Security Engineering  ☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):

☐ 1 meeting per week
☐ 1 meeting per month
☐ 2 or more meetings per month
☐ 1 meeting per semester

☐ In person, ☐ Over the phone, ☑ Web / video conferencing

Other Client Interaction Preferences:

☐ 1 meeting per month
☐ 2 or more meetings per month
☐ 1 meeting per semester

☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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<th>0 – Not at all</th>
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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj039
☐ Project Assigned:
☐ Advisor(s) Assigned:

__________________________________________________________________

__________________________________________________________________
Project Title:
High-Resolution ADC Using Delta-Sigma Architectures

Project Abstract:
Analog to digital converters (ADCs) are widely used to convert analog signals to the digital domain. There are dominantly two major classes of data converters, one is termed Nyquist Rate converters and the other are termed Over-Sampled Data Converters or Delta-Sigma Data Converters. With Nyquist rate converters, samples of the input are converted to a Boolean signal when each sample is taken. In Over-sampled Data Converters, a large number of low resolutions are made with each sample and the large number of low resolution outputs are then combined (decimated) into a higher-resolution output. Over-sampled data converters invariably have a low effective conversion rate but can achieve very high resolution. For example, over-sampled converters can readily achieve an effective resolution of 20-bits or more with a low sample rate and with relatively simple circuits. This project will involve the design of a slow-speed over-sampled data converter and the use of this data converter to provide a high-resolution digital output of an on-chip temperature sensor.

Expected Deliverables:
There are 3 deliverables. The first is an assessment of the performance capabilities and limitations of over-sampled data converters. The second will be the design of an over-sampled data converter targeting a sampling rate of at least 1K samples/second with a resolution of at least 16 bits. The third will be the design of an on-chip temperature sensor that provides an output voltage that has a monotone relationship with temperature over the temperature range from 10°C to 60°C. The design should include a layout and selected post-layout simulations. The MOSIS service will be used for fabrication of the ADC which should be completed by the start of the fall semester. The fourth will be testing results for the ADC and the temperature sensor. Finally, an assessment of the overall performance of the ADC and the temperature sensor will be expected based upon the experimental results and their relation to the simulation results.

Specialized Resources Provided by Client:

Anticipated Cost: _______________  Financial Resources Provided by Client: _______________

Preferred Students for the Project:
☑ Electrical Engineering  Other Special Skills:
☐ Computer Engineering
☐ Software Engineering
☐ Cyber Security Engineering
☐ Other:
Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing

☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☐ Web / video conferencing

Meeting ABET Criteria

Please rate the following statements as they relate to your proposed project:

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☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project requires students to identify, formulate, and solve engineering problems
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

This project gives students an opportunity to use the techniques, skills, and modern engineering tools necessary for engineering practice
☐ 0  ☐ 1  ☐ 2  ☐ 3  ☑ 4

Project Approval – for use by ECpE Senior Design Committee

☑ Approved: .sddec21-proj040

☐ Project Assigned:

☐ Advisor(s) Assigned:
Project Title: Vendor Security Review Process Portal

Project Abstract:
In Healthcare, security for information systems is as important or even more so than in other industries. UnityPoint Health – Des Moines (UPHDM) enacts processes to ensure all systems that may be utilized pass certain criteria for safety and security. However, these processes are often manual, not transparent to customers and users, and are disjointed leading to large lead times for implementation of solutions.

We are imploring a student team of software and security experts to create a software system or portal that not only addresses the process time to review and approve software, but also employs their knowledge of security to ensure the right information is being procured and evaluated. In this way, it is a two-fold use of the skills of the students which would have an enormous impact on ensuring fast and safe patient care when new technologies are required.

Expected Deliverables:
- Evaluation of Current System to evaluate and approve new technologies for UPHDM
- Development of New Software Portal (web-based or otherwise) to connect all necessary parties to the processing of information as new technologies are reviewed and approved
- Ability to track turn-around time of requests and reasons for delays
- Research of current best practices in enacting Vendor Security Reviews

Specialized Resources Provided by Client:
None required; we are open to the exploration of many different platforms for this work.

Anticipated Cost: ____________________  Financial Resources Provided by Client: ____________________

At this time, we are unable to provide monetary resources to students due to COVID-19 impacts on healthcare. However, many student groups have worked with us and we still allow that on a case by case basis, if funds are required, we can explore the possibility.
Preferred Students for the Project:
- [☐] Electrical Engineering
- [☑] Computer Engineering
- [☑] Software Engineering
- [☑] Cyber Security Engineering
- [☐] Other: [ ] Other Special Skills: This project has an emphasis on software development and understanding of cyber-security.

Anticipated Client Interaction (estimate):
- [☐] 1 meeting per week
  - [☐] In person, [☐] Over the phone, [☐] Web / video conferencing
- [☑] 1 meeting per month
  - [☐] In person, [☐] Over the phone, [☑] Web / video conferencing
- [☐] 2 or more meetings per month
  - [☐] In person, [☐] Over the phone, [☐] Web / video conferencing
- [☐] 1 meeting per semester
  - [☐] In person, [☐] Over the phone, [☐] Web / video conferencing

Meeting ABET Criteria
Please rate the following statements as they relate to your proposed project:

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- [☐] 2
- [☐] 3
- [☑] 4

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- [☐] 0
- [☐] 1
- [☐] 2
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This project involves students from a variety of programs, i.e., CprE, EE, and SE
- [☐] 0
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- [☐] 0
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Project Approval – for use by ECpE Senior Design Committee
- [☑] Approved: sddec21-proj041
- [☐] Project Assigned: [ ]
☐  Advisor(s) Assigned:  

______________________________
Project Title:
A Wearable Medical Diagnostic Patch

Project Abstract:
The project is to develop wearable sensor patches for constant and/or instant sensing of different physiological data streams, including movement, temperature, hydration, electrocardiogram, electromyography, force myograph, hear rate, and blood oxygen saturation level. The system will include both hardware and software. The output signals of the patch will be transmitted to a smart phone through a wireless interface. The patch will track the body’s vital signs. Testing of the patch will be conducted on both human and animals.

Expected Deliverables:
Spring 2021 deliverables: 1. Work plan (Month 1); 2. Parts selection and purchase, APP initial design (Month 2-3); 3. Initial testing of an integrated patch and APP (Month 4-4.5). Fall 2021 deliverables: 1. Work plan (Month 1); 2. Optimization of the integrated patch and APP (Month 2). 3. Animal testing in Vet Medicine College (Month 3). 4. Hussam testing (Month 4). 5. Report (Month 4.5)

Specialized Resources Provided by Client:
General hardware and software resources in ECpE department.

Anticipated Cost:  
Financial Resources Provided by Client: NA

Preferred Students for the Project:
☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills:

Anticipated Client Interaction (estimate):
☐ 1 meeting per week
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☐ 1 meeting per month
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
☑ 2 or more meetings per month
  ☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
  ☐ In person, ☐ Over the phone, ☐ Web / video conferencing
### Meeting ABET Criteria

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### Project Approval – for use by ECpE Senior Design Committee

- Approved: sddec21-proj042
- Project Assigned: 
- Advisor(s) Assigned: 

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Project Title:
App for microgrid demonstration project

Project Abstract:

Goal is to develop one or more apps to show operating data from a solar/Tesla powerwall storage/wind/diesel/car charging off-grid microgrid operating in Ames. Students will be expected to develop layers of information so that the public will be able to have overall information about the microgrid's performance, but also that researchers can access voltage, current, frequency data. The app may also have alerts for low battery state of charge.

Expected Deliverables:

In the first semester students will be expected to have developed an app that at least displays the solar data and have a prototype to display the battery data. In the second semester students will add the car charging, other load, and diesel data.

Specialized Resources Provided by Client:

EPRC will provide access to the microgrid and access to the current remote desktop that has operating data (all devices are connected by ethernet to a laptop at the microgrid).

Anticipated Cost: ____________________________
Financial Resources Provided by Client: request

Preferred Students for the Project:

☑ Electrical Engineering
☑ Computer Engineering
☑ Software Engineering
☐ Cyber Security Engineering
☐ Other:

Other Special Skills: interest in microgrids and in renewable energy and energy storage integration

Anticipated Client Interaction (estimate):

☑ 1 meeting per week
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 2 or more meetings per month
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
☐ 1 meeting per semester
☐ In person, ☐ Over the phone, ☑ Web / video conferencing
Meeting ABET Criteria

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Project Approval – for use by ECpE Senior Design Committee

☑ Approved: sddec21-proj043
☐ Project Assigned: ________________________________
☐ Advisor(s) Assigned: ________________________________