EEE4022S/F Topic template

Student proposed?	*Y/N*	*N*
ID:	**SC-01**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**INVESTIGATING THE IMPACT OF INTEGRATING INVERTER-BASED SOLAR PV PLANTS ON PROTECTION SYSTEM IN A UTILITY NETWORK**	
DESCRIPTION:	The output of solar PV plants can be intermittent due to variation in solar resource. When solar PV plants are integrated to a grid at the sub-transmission or distribution level, the placement and capacity of the plants, their intermittent generation and level of penetration are likely to impact the existing protection system in the utility network. This project will investigate the impact of inverter-based solar PV plant integration on fault currents and existing protective relay operation in a power network. Factors to be considered will be plant placement and capacity, generation and level of penetration, voltage of integration and utility grid strength.	
DELIVERABLES:	i) Review of protection challenges in a power network with grid-integrated distributed generation. ii) Review of impact of inverter-based solar PV integration on utility network protection. iii) Designing a test network with grid-integrated solar PV power plants. The design steps followed must be shown. iv) Developing criteria for investigating the impacts on fault current and operation of protective relays. v) Interpretation of results and conclusions.	
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year Power and Machine courses Software : MATLAB, DIgSILENT Powerfactory	
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex because it does not specify the grid strength, location and capacity of the solar PV plants, level of penetration, integration voltage, fault locations, and type of faults. These are to be decided by the student to address the research topic.	
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Collecting data or using any benchmark system for simulating the utility grid. ii) Selecting the simulation software. iii) Collecting/preparing data to simulate a realistic inverter-based solar PV plant. iv) Simulating an integrated model with the solar PV plant, utility grid, loads and protection system. iv) Investigating the impact on fault current and protective relay operation and recommend best integration strategy v) Interpretation of results and conclusions.	
EXTRA INFORMATION:	Data collection should be from open sources. If any data is assumed, the assumptions must be clearly explained.	

BROAD Research Area:	Grid Integration of Distributed Generation, Renewable Energy Systems
Project suitable for ME/ ECE/EE/ALL?	EE

***NOTE: Complex engineering problems** require in-depth fundamental and specialized engineering knowledge and

- have one or more of the characteristics: are ill-posed, under- or overspecified, or require identification and refinement; are high-level problems including component parts or sub-problems; are unfamiliar or involve infrequently encountered issues;
- and their solutions have one or more of the characteristics: are not obvious, require originality or analysis based on fundamentals; are outside the scope of standards and codes; require information from variety of sources that is complex, abstract or incomplete;
- involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

****NOTE: GA 4:** The balance of **investigation and experiment** should be appropriate to the discipline. Research methodology to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline. An **investigation differs from a design** in that the objective is to produce knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.

Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set		X
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		
Q8	Are the third-party data used from an open source?		
Q9	Are the third-party data used from a different research group?		

Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

Student proposed?	*Y/N*	*N*
ID:	**SC-02**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**OPTIMAL DESIGN OF ISLANDED HYBRID RENEWABLE ENERGY SYSTEM FOR ELECTRIC VEHICLE CHARGING FACILITIES**	
DESCRIPTION:	Islanded hybrid renewable energy systems (HRESs) with storage are being widely deployed for electrifying off-grid facilities across the globe. This project involves designing cost-effective and environmentally friendly stand-alone HRES with storage for an African farm using a mix of plant and animal wastes. Design must always ensure energy security, considering seasonal variation in availability of biomass. The idea behind the project is to secure reliable energy supply for timely charging electric vehicles.	
DELIVERABLES:	i) Review of stand-alone HRES and storage design and applications for electric vehicle charging. ii) Assessment of electric vehicle charging facility load profile and renewable resource. ii) Design of cost-effective stand-alone HRES with storage along with design steps followed. iii) Technical and economic feasibility analysis of the system to obtain the optimal solution in terms of cost-effectiveness, energy security and minimum emissions. iv) Interpretation of results and conclusions.	
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year power and machine courses Software : HOMER Pro	
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex because it does not specify the region where the charging facility is located, the traffic network and local renewables. These are to be decided by the student to address the research topic.	

GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Selecting a suitable location, collecting renewable data, component, and load data to develop a realistic stand-alone HRES. ii) Selecting suitable simulation software. iii) Developing various energy system configurations with storage to suit resource availability and load profile. iv) Performing technical and economic feasibility analysis and evaluation of environmental impact of the optimum configuration for different case studies.
EXTRA INFORMATION:	Data collection should be from open sources. If any data is assumed, the assumptions must be clearly explained.
BROAD Research Area:	Renewable Energy Systems, Energy Storage, Electric Vehicles
Project suitable for ME/ ECE/EE/ALL?	EE, ME

***NOTE: Complex engineering problems** require in-depth fundamental and specialized engineering knowledge and have one or more of the characteristics:

- are ill-posed, under- or overspecified, or require identification and
- refinement; are high-level problems including component parts or sub-
- problems; are unfamiliar or involve infrequently encountered issues;

and their solutions have one or more of the characteristics:

- are not obvious, require originality or analysis based on fundamentals; are
- outside the scope of standards and codes; require information from variety of
- sources that is complex, abstract or incomplete;
- involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

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Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set		X
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No

Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		
Q8	Are the third-party data used from an open source?		
Q9	Are the third-party data used from a different research group?		
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

Student proposed?	*Y/N*	*N*
ID:	**SC-03**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**DESIGN AND ENERGY MANAGEMENT OF HYDROGEN FUEL CELL POWER PLANT**	
DESCRIPTION:	Hydrogen fuel cell plants are gaining popularity as a clean energy source for decarbonizing the energy sector. Hydrogen fuel cells produce electricity by combining hydrogen and oxygen atoms. The hydrogen reacts with oxygen across an electrochemical cell to produce electricity, water, and small amounts of heat. This project deals with mathematical modelling and simulation of a hydrogen fuel cell power plant with its energy management system (EMS). The model and EMS performance will be tested under various load profiles with the aim of maintaining uninterrupted power supply to the loads. The plant may be hybridized with any other renewable resource. It must be able to operate in both islanded and grid-tied modes.	

DELIVERABLES:	i) Problem description with scope and limitations ii) Literature review aligned to the problem iii) Methodology for the research including data collection/preparation, selection of software, developing the hydrogen fuel cell power plant test system, designing the EMS, and planning the case studies/testing criteria complying to the set system frequency iv) Presentation and analysis of results v) Conclusion and recommendation
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year Power and Machine courses Software : MATLAB, DIgSILENT Powerfactory
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex in that it does not specify (a) the load categories and profiles, (b) type/capacity of the hydrogen fuel cell plant or (c) control strategy to be employed. Student must develop (a)-(c) on their own to develop the test system and controller functionalities, and plan case studies/test criteria complying with the power supply requirements.
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Literature review aligned to the problem ii) Data collection/preparation and selecting suitable software iii) Developing the fuel cell power plant test system iv) Designing the control scheme for load following v) Planning the case studies and testing criteria vi) Modelling and simulation of case studies to obtain the results vii) Analysis of results, conclusion, and recommendation
EXTRA INFORMATION:	Data collection should be from open sources. If any data is assumed, the assumptions must be clearly explained.
BROAD Research Area:	Renewable Energy Systems
Project suitable for ME/	EE, ME
ECE/EE/ALL?	

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Ethics clearance questionnaire

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Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set		X
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		
Q8	Are the third-party data used from an open source?		
Q9	Are the third-party data used from a different research group?		
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

Student proposed?	*Y/N*	*N*
ID:	**SC-04**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**INVESTIGATING THE IMPACT OF INTEGRATING INVERTER-BASED WIND POWER PLANTS ON POWER SYSTEM STABILITY**	

DESCRIPTION:	The output of a wind power plants can be intermittent due to variation in wind resource. When inverter-based wind power plants are integrated to a grid at the subtransmission or distribution level, the plant location and capacity, level of penetration and their intermittent generation are likely to impact the stability of the utility power network. Poor integration planning can worsen the steady state and transient stability for the network. This project will investigate the impact of inverterbased wind power plant integration on power system stability in a utility network. Factors to be considered will be capacity, generation and placement of the PV plant, and utility grid strength.
DELIVERABLES:	i) Review of stability challenges in a power network with grid-integrated distributed generation. ii) Review of impact of inverter-based wind energy integration on utility network stability. iii) Designing a test network with grid-integrated wind power plants. The design steps followed must be shown. iv) Developing criteria for investigating the impacts of the wind energy integration on stability for the utility network. v) Interpretation of results and conclusions.
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year power and machine courses Software : MATLAB, DIgSILENT Powerfactory
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex because it does not specify the grid strength, location and capacity of the wind power plants, level of penetration, integration voltage, and type of stability. These are to be decided by the student to address the research topic.
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Collecting data or using any benchmark system for simulating the utility grid. ii) Selecting the simulation software. iii) Collecting/preparing data to simulate a realistic inverter-based wind power plant. iv) Simulating an integrated model with the wind power plant, utility grid and loads. iv) Investigating the impact on power system stability and recommend the best integration strategy. v) Interpretation of results and conclusions.
EXTRA INFORMATION:	Data collection should be from open sources. If any data is assumed, the assumptions must be clearly explained.
BROAD Research Area:	Grid Integration of Distributed Generation, Renewable Energy Systems, Power System Stability
Project suitable for ME/ ECE/EE/ALL?	EE

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Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set		X
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		
Q8	Are the third-party data used from an open source?		
Q9	Are the third-party data used from a different research group?		
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		

Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

Student proposed?	*Y/N*	*N*
ID:	**SC-05**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**DESIGN, ENERGY MANAGEMENT AND COST ANALYSIS OF SOLAR PV-BATTERY UNINTERRUPTED POWER SUPPLY (UPS)**	
DESCRIPTION:	This project involves design, energy management and cost analysis of a solar PVbattery UPS for a selected consumer premise. The design must ensure that the consumer has uninterrupted power supply during operational hours. The energy management system (EMS) should schedule solar PV operation depending on resource availability with maximum power point tracking (MPPT), battery charging and discharging, and a diagnostic check for the overall system. Solar charging of the battery should be considered.	
DELIVERABLES:	i) Review of solar PV-battery UPS system, power quality and load matching, energy management, battery health check, load profiling etc. ii) Collect energy consumption data for a selected consumer premise. iii) Design the solar PV-battery system, MPPT controller battery operation schedule, energy management system and system health check criteria. All design steps must be shown. iv) Testing and performance validation and cost analysis of the UPS to meet its desired functions. v) Interpretation of results and conclusions.	
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year power and machine courses Software : MATLAB, DIgSILENT Powerfactory	
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex because it does not specify the location and type of consumer, type of battery, and control algorithm. These are to be decided by the student to address the research topic.	
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Collecting data for energy consumption for the selected premise. ii) Selecting the simulation software. iii) Collecting/preparing data to simulate a realistic solar PV-battery UPS. iv) Simulating an integrated system model with the solar PV system, battery, controller, and loads. iv) Testing the system and controller for various load profiles and operational scenarios. v) Cost analysis of the overall system. vi) Interpretation of results and conclusions.	

EXTRA INFORMATION:	Third party data collection is needed for generating the load profile. Third party data will be used with written permission and with full confidentiality and anonymity. Proof of permission will be attached to the PSQ. If a third party cannot be identified then data will be collected from open sources.
BROAD Research Area:	Renewable Energy Systems, Energy Storage
Project suitable for ME/ ECE/EE/ALL?	EE, ME

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and their solutions have one or more of the characteristics:

are not obvious, require originality or analysis based on fundamentals; are outside the scope of standards and codes; require information from variety of sources that is complex, abstract or incomplete;

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Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set	X	
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)	X	

Q8	Are the third-party data used from an open source?		X
Q9	Are the third-party data used from a different research group?	X	
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		X

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

Student proposed?	*Y/N*	*N*
ID:	**SC-06**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**INTELLIGENT ENERGY MANAGEMENT SCHEME OF A HYBRID MICROGRID USING MACHINE LEARNING TECHNIQUES**	
DESCRIPTION:	This project deals with the design of an intelligent energy management scheme for a hybrid microgrid using machine learning techniques. The microgrid must not have more than 1MW generation. The microgrid should be able to operate in both islanded and grid-tied modes. It should be able to provide uninterrupted and quality power to its own loads and must also be able to exchange power with the utility if there is excess generation. The EMS should be designed to match the generation and load demand on the microgrid under both islanded and grid-tied operation. It should also be able to control charging and discharging of the battery or to execute load shedding during a drastic generation shortfall. The aim of the scheme will be to maintain power quality at the load terminals under all operating conditions.	
DELIVERABLES:	i) Review of hybrid microgrid energy management and intelligent energy management algorithms. ii) Design and simulation of test microgrid, loads and the intelligent energy management scheme. All design steps should be clearly shown. iii) Testing and validation of the performance of the scheme for various modes of operation and loading/resource availability conditions. iv) Interpretation of results and conclusions.	
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year power and machine courses Software : Matlab, DIgSILENT Powerfactory	

GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex because it does not specify the type of load profile and the type of machine learning energy management algorithm. These are to be decided by the student to address the research topic.
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Collecting data for developing the load profile. ii) Selecting the simulation software. iii) Collecting/preparing data to simulate a realistic battery-powered uninterrupted power supply. iv) Simulating an integrated system model with the battery, controller, and loads. iv) Testing the system and controller for various load profiles and operational scenarios. v) Cost analysis of the overall system. vi) Interpretation of results and conclusions.
EXTRA INFORMATION:	Data collection should be from open sources. If any data is assumed, the assumptions must be clearly explained.
BROAD Research Area:	Microgrids, Machine Learning
Project suitable for ME/	EE, ME
ECE/EE/ALL?	

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- involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

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Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set		X

Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?	X	
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		
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Q9	Are the third-party data used from a different research group?		
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

Student proposed?	*Y/N*	*N*
ID:	**SC-07**	
SUPERVISOR:	**SUNETRA CHOWDHURY**	
TITLE:	**DESIGN OF LOSS OF GRID PROTECTION SCHEME FOR A HYBRID RENEWABLE ENERGY SYSTEM INTEGRATED AT SUB-TRANSMISSION OR DISTRIBUTION NETWORK**	
DESCRIPTION:	Several voltage and frequency-based Loss of Grid (LOG) protection schemes are currently used to detect and disconnect a renewable power plant during a grid fault, allowing the plant to operate in islanded mode supplying its own loads. This project deals with the design of a suitable LOG scheme for a hybrid renewable energy system (HRES) integrated at sub-transmission or distribution levels in a utility grid. The scheme must operate reliably for both balance and unbalanced grid faults. The scheme must also be tested for various combinations of rotational and static generation.	

DELIVERABLES:	i) Review of LOG schemes for renewable distributed generation. iii) Designing an LOG scheme for an HRES. The design steps followed must be shown. iv) Testing and performance comparison of the LOG scheme for different grid-fault types (balanced and unbalanced) and locations (measured from the point of common coupling), different grid strengths and different combinations of rotational and static generation in the HRES. v) Interpretation of results and conclusions.
SKILLS/REQUIREMENTS:	Preferred courses : 4th Year power and machine courses Software : MATLAB, DIgSILENT Powerfactory
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	The problem is open-ended and complex because it does not specify the grid strength, capacity and configuration of the HRES, integration voltage, fault types or locations and any testing criteria. These are to be decided by the student to address the research topic.
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	i) Developing the test network. ii) Selecting the simulation software. iii) Modelling and simulation of a realistic HRES. iv) Simulating an integrated model with the HRES, utility grid and the loads. v) Design and simulation of LOG scheme. vi) Testing the LOG scheme for different grid fault types and locations, different grid strength and different combinations of rotational and static generation in the HRES.
EXTRA INFORMATION:	Data collection should be from open sources. If any data is assumed, the assumptions must be clearly explained.
BROAD Research Area:	Renewable Energy Systems, Power System Protection, Grid Integration of Distributed Generation.
Project suitable for ME/ ECE/EE/ALL?	EE

***NOTE: Complex engineering problems** require in-depth fundamental and specialized engineering knowledge and have one or more of the characteristics: are ill-posed, under- or overspecified, or require identification and refinement; are high-level problems including component parts or sub-problems; are unfamiliar or involve infrequently encountered issues; and their solutions have one or more of the characteristics: are not obvious, require originality or analysis based on fundamentals; are outside the scope of standards and codes; require information from variety of sources that is complex, abstract or incomplete;

- involve wide-ranging or conflicting issues: technical, engineering and interested or affected parties.

****NOTE: GA 4:** The balance of **investigation and experiment** should be appropriate to the discipline. Research methodology to be applied in research or investigation where the student engages with selected knowledge in the research literature of the discipline. An **investigation differs from a design** in that the objective is to produce

knowledge and understanding of a phenomenon and a recommended course of action rather than specifying how an artifact could be produced.

Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		X
Q2	Does this project involve utilizing a third-party data set		X
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		X
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		X
Q5	Does this project involve external parties, funders, etc		X

Answer the following questions if you answer "**Yes**" to any of the above questions. If the answer is "**Yes**" to **Q1**, please answer the following questions:

		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		
Q8	Are the third-party data used from an open source?		
Q9	Are the third-party data used from a different research group?		
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		

EEE4022S/F Topic template

Student proposed?	*Y/N* *Y*	*If Y, student name* *STHKIM002*
ID:	**SC-08-STHKIM002**	
SUPERVISOR:	Sunetra Chowdhury	
TITLE:	Portable battery-powered water heating device	

DESCRIPTION:	During loadshedding, residents in townships tend to bath with cold water which can be very stressful and can worsen health issues and the overall situation of living in a township. To address this problem, this project proposes designing and building a small, portable water heating device that can heat up to 25 liters of water contained in a bucket or tub. To cater to township residents and to be used during loadshedding, the product should not be expensive and should be battery-operated. There will be provision that the battery is charged using a built-in solar PV source and/or a plug-in power source. The device will have a water-proofing cover that for it to be easily dipped in water making its usage easy. It must be ensured that no part of the battery and charging system are damaged by water while the system is being used. The device should also have a thermostat that puts it off once the maximum water temperature setting is exceeded.
DELIVERABLES:	A report A software design and coding A hardware product
SKILLS/REQUIREMENTS:	Design skills, programming skills, control engineering skills, power engineering skills
GA 1: Problem solving: *Identify, formulate, analyse and solve complex* engineering problems creatively and innovatively*	*(Explain briefly how the topic lends itself to meet the GA requirement)* The problem is complex and open-ended as it does not specify the amount of water to be heated, maximum water temperature to be reached, what type of battery to be used and specific design features including safety features.
GA 4: Investigations, experiments and analysis:** *Demonstrate competence to design and conduct investigations and experiments.*	*(Explain briefly how the topic lends itself to meet the GA requirement)* The solution, being a portable battery-powered water heating device, is unique that has not been created before and therefore will require research and investigation on building the different subsections to achieve the solution and build the product. A thorough literature review will be firstly conducted on water heating applications, battery applications in water heating, control and battery charging systems, design and costing. Secondly, design, coding, and simulation studies will be undertaken to test the design in a simulation platform. Thirdly, cost analysis will be done along with producing a list of components. Fourthly, necessary material must be procured and the product will be built. Finally the actual product must be tested for its usability and efficiency. While creating a user interface of the device when it comes to temperature to heat up the device, will require analysis and control engineering knowledge. This solution presents all the quantities for GA4 as explained above.
EXTRA INFORMATION:	None
BROAD Research Area:	Solar PV, energy storage, energy consumption

Project suitable for ME/ ECE/EE/ALL?	ECE and EE

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Ethics clearance questionnaire

		Yes	No
Q1	Does this project involve data collection		N
Q2	Does this project involve utilizing a third-party data set		N
Q3	Does this project utilize machine learning (ML) or artificial intelligence (AI)?		N
Q4	Does it exceed the minimum risk defined here: Link [Answer is No here if your project does not utilize ML and AI]		N
Q5	Does this project involve external parties, funders, etc		N

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		Yes	No
Q6	Are there humans or animals directly involved in the data collection process or contains any identification information		N

If the answer is "**Yes**" to **Q2**, please answer the following questions:

		Yes	No
Q7	Are the third-party data used anonymous (data does not contain human or animalrelated information?)		N
Q8	Are the third-party data used from an open source?		N
Q9	Are the third-party data used from a different research group?		N
Q10	If the answer to **Q9** is "**Yes**", do you have the approval to use third-party data sets? Attach the proof to PSQ application.		N

If the answer is "**Yes**" to Q5, please answer the following questions:

		Yes	No
Q11	Have you signed an MOU between the parties [If Yes, attach the proof to PSQ application.]		N
Q12	Will there be a chance for any conflict of interest between the parties? [If Yes, provide details of the issue and your plan to solve it]		N