King Saud University
College of Engineering
Electrical Engineering Department **Semester: 421** **Project # P1**

Graduation Design Project Proposal Form

Project Title: **Design of a static VAR compensator (SVC) for Increasing Power Transfer Capability of the East-Central Interconnection System.**

Professor(s) Name(s): **Abdullah M. Al-Shaalan**

Number of Students: **2 - 3**

Statement of Problem:

A study of the dynamic capability of increasing the power transfer limit of the electric interconnection between the two Saudi Electricity Company (SEC) operating areas, namely, Eastern Operating Area (SEC-EOA) and the Central Operating Area (SEC-COA) is the main concern of this project. Such a study is highly needed since inadequate or forced outages, impose undesired limitations on the operation continuity and service quality of power systems. In some cases, they cause system separation if the system is exposed to capacity deficit or severe outages. This work is also important to SEC-EOA in extending the power transfer capability through the SEC-EOA / SEC-COA interconnection transmission line. One of the possible, and may be the more, effective solutions to remedy and avoid such problems is to install SVC facilities in selected positions along the transmission lines interconnecting the two SEC operating areas.

Brief Description of the Project:

A static VAR compensator (SVC) is generally needed in a transmission line system to reduce transmission losses and improve power system transfer capability to serve the end loads. It is often desirable to adjust the power factor of a system to near 1.0 by installing SVCs. When reactive elements absorb reactive power near the load, the apparent power is reduced which means minimizing wasted energy, improving the efficiency of power system components and reducing the electricity costs. Therefore, in this project, SVC facilities will be applied in order to bring the power factor of the tie-line, under study, closer to 1 by supplying reactive power of opposite sign, adding capacitors or inductors that act to cancel the inductive or capacitive effects of the load, respectively. For example, the inductive load of a transmission line may be offset by locally connected capacitors. If a load had a capacitive value, inductors (also known as *reactors* in this context) are connected to correct the power factor.

Objectives:

There are several objectives that can be gained as a result of undertaking this project, namely:

1) Enhancing and extending the transfer capability of the SEC-EOA/SEC-COA power to avoid system collapse after possible major capacity deficits or severe outages.
2) Increasing the capacity transfer capability and efficiency of the tie-line interconnecting between the two operating areas under study which yield more active and utilized power and less wasted power.
3) Additional capacity (electric power) can be achieved without supplying it from the source (electric company.
4) Developing a set of recommendations that will be useful for the power systems planning and operation engineers in Saudi Arabia based on the obtained results in items 1–3. These recommendations will be invaluable for the interconnection projects that will take place in near future between the other regions within the the Kingdom as well as between the Kingdom and its neighboring countries.

Technical Approach and Expected Deliverables:

The design method proposes a static VAR compensator (SVC) facilities that consist of a number of capacitors switched by means of contactors. These contactors are controlled by a regulator that measures power factor in an electrical network. Depending on the load and power factor of the network, the power factor controller will switch the necessary blocks of capacitors in steps to make sure that the power factor matches the selected value. Instead of using a set of switched capacitors, an unloaded synchronous motor can supply reactive power. The reactive power drawn by the synchronous motor is a function of its field excitation. This is referred to as a *synchronous condenser*. It is started and connected to the electrical network. It operates at a leading power factor and puts VAR onto the network as required to support a system's voltage or to maintain the system power factor at a specified level. The expected deliverables of this project can be visualized as 1) increased power transmission capability of the transmission lines 2) improved the transient stability of the system 3) controlled the steady state and temporary overvoltages 4) improved the load power factor, and therefore, reduced line losses and improved system capability.

Project # P2

Project Title:
Design of appropriate protection measures to reduce the effects of electromagnetic Interference (EMI) caused by electrical equipment operated at proximity.

Professor(s) Name(s): Abdullah M. Al-Shaalan

Number of Students: 2 -3

Students Qualifications:

Statement of Problem:

Electromagnetic Interference (EMI) is a mutual radiation emission caused by the proximity of electrical equipment operating in one site and environment. This phenomenon produces adverse effects upon equipment that can degrade and reduce their functionality and performance. These bad effects can be an electromagnetic noise, an unwanted signal, erroneous results in data information, paricularly in medical clinics and intensive care units.

The solution for these undesirable effects can be achieved through the most recent developments in the field of Electromagnetic Compatibility (EMC) and its applications to the equipment design. This solution leads to the ability of an equipment to function sutisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances or mal functioning in equipment operation and function in any particular conditions is likely to be subjected in.

Brief Description of the Project:

This project aims at compiling and collecting a comprehensive information, data, studies, and results related to the effects of Electromagnetic Interference (EMI) on the functional operation of equipment working in one close site or surrounded environment. The project will try to design proper protection measures to by utilizing the most recent developments in the field of Electromagnetic Compatibility (EMC) and its applications to the equipment design to reduce the effects of Electromagnetic Interference (EMI) caused by electrical equipment operated at proximity. Therefore, this project will try intensively to scrutinize and comprehend most of the research related to this area and to and analyze all information, data and results that have been accessed and obtained in the field of exposure to electromagnetic fields.

Objectives:

1) Reducing the effects of the phenomenon known as the “Electromagnetic Interference (EMI)” which causes interference between the adjacent devices and equipment operating within close vicinity.
2) Enhancing and ensuring safety measures, precautions and design of electrical devices and equipment.
3) Reinforce medical opinions, observations and stances towards these issues.

Technical Approach

To achieve the prescribed objectives of this project, the following tasks shall be carried out:

1) Collecting the largest number of reports, research and standard specifications that dealt with the phenomenon of Electromagnetic Interference (EMI) and its unfavorable effects on equipment performance operating in close vicinity and surrounding environment.
2) Benefiting from the standards issued by the Saudi Arabian Standards Organization (SASO), the International Electrotechnical Commission (IEC) and the International Standard Organization (ISO) on electromagnetic radiation and their effects on equipment proper functionality and performance.
3) Undertaking design protective measures like, for example: **i)** grounding and shielding **ii)** decoupling or filtering **iii)** emission suppression and testing **iv)** EMC testing **v)** susceptibility testing.

Expected Deliverables:

1) Finding proper solutions to the “electromagnetic compatibility, EMC” in equipment design and operation. The EMC requires that equipment should be able to tolerate a specified degree of interference and not generate more than a specified amount of interference**.**
2) Arriving at securing measures and precautions in the design of electrical equipment, appliances, devices to reduce their electromagnetic radiation and hence, mitigating their harmful effects on data results, users and on the environment.
3) Enriching the studies and research in this area of interest. .

Project # P3

Project Title: **Design of a Domestic Electric Charger for an Electric Vehicle**

Professor(s) Name(s): Abdullah M. Al-Shaalan

Number of Students: 2 - 3

Students Qualifications:

Statement of the Problem:

Electric Vehicle (EV) is an electric car that has an alternative fuel automobile that uses electric motors for propulsion, in place of more common propulsion techniques such as the internal combustion engine (ICE). Electricity can be used as a transportation fuel to supply battery of electric vehicles (EVs). EVs store electricity in an energy storage device, such as a battery. The electricity powers the vehicle's wheels via an electric motor. EVs have limited energy storage capacity, which must be charged by plugging into an electric source through an electric charger. For this reason,

Several important factors such as efficiency, safety, dependability, and adequacy are to be taken into consideration in the designing process for these electric chargers for these types of cars.

Brief Description of the Project:

The Kingdom of Saudi Arabia intends to import the electric cars to its markets considering that these types of cars will have positive effects in saving fuel costs and preserving the environment from pollution. Electric vehicles are divided into two main parts: the first one is a Plug-in Hybrid Electric Vehicles (PHEV) that contains two propulsion systems. The first one is a system powered by an electric motor linked to a Rechargeable Energy Storage System (RESS) and a system powered by an Internal Combustion Engine (ICE) based on fuel filling. The second one is an Electric Vehicle (EV) that contains one or more electric motors and are fed by storage batteries that are charged from electric source through an electric charger. The aim is to design a domestic electric charger for the EV that comply with the national and international standards issued by the Saudi Arabian Standards Organization (SASO SBC 401) as well as to be compatible with the International Standard Organization (ISO15118) and the International Technical Committee (IEC 62752).

Objectives:

In this project. It is hoped to arrive at the perfect design of the following

- Safe, and convenient to use electric charger for the electric vehicle to be installed at the premises.
- Appropriate plugs and sockets that are safe and secured to both the user and to the car.
- Building an electric energy storage (batteries) to cope up with long drive distances.

Technical Approach:

The design approach will focus completey on safety and comfort for the user of those cars and adopting the following designing procedures:

- Installing sockt-outlets that are compatible with SASO SBC 401 standard.
- Integrating an AC-DC battery for electric vehicle (3 conductors) with AC charging and rated supply voltage of 400/230 V to charge electric vehicles based on the three international standards IEC 61851.1, IEC 61851.23 and IEC 62196 suitable for charging in residential installations.
- Selecting a connecting cables between the electric charging source and the car battery to be reliable, secured, and with good insulation and mechanical resistance in order to protect the user from electric shock and protects the car from the occurrence of a short circuit as a result of direct contact.
- Ensuring the existence of a robust grounding (earthing) system for electrical installations to the electrical supply. Its cross-sectional area will be determined by reference to the tables in IEC 62196.

Expected Deliverables:

Since the EV consumes less energy compared to cars that use gasoline and for its popularity as a non-pollutant to the environment, the EVs will be soon imported to the Saudi markets. For this reason, this project will devote its endeavor in this direction and expect to realize the following deliverables:

- Installing electric charging statations at residential homes in anticipation for future flow of EVs to be imported and marketed in the Kigdom.
- Safe, sound and dependable connecting home electric charger to the EV with all accessories (sockt-outlets. insulated core, size, earthing).
- Improving the Saudi national standards in relation to the electric vehiles.

Project # P4

Project Title: Design and Analysis for a Residential Renewable Energy Systems in KSA (1).

Professor(s) Name(s): 1.Dr. Wonsuk Ko 2. Dr. Essam Al-Ammar

Number of Students: Two

Students Qualifications

Students should have good background in renewable modeling and economic analysis.

Statement of Problem

Due to the COVID-19, in this project we are going to only simulate and analysis for a "Design and Analysis for a Residential Renewable Energy Systems in KSA". To design Renewables, first understanding Renewable energy principles and then Load analysis of Residential in KSA. Then investigating regulation of KSA, calculating required power consumption of each household. Finally, simulating and economic analysis of your renewable system.

Brief Description of the Project

This project investigates Residential Renewable Energy Systems for KSA. The unique approach of this project is we need two teams for design renewables, one team researches traditional house as AC based and the other as DC based, and both consider grid off and grid tied.
The objective of proposed project is to design renewables for residential in KSA and understand the install approach in KSA. After designing renewables for residential, economic analysis is required using simulation.

Objectives

(1) Understanding Renewable Energy Principle
(2) Assessment of Current Energy Consumption in Residential, KSA
(3) Load Analysis of Residential, KSA
(4) Designing Renewable Energy System for Residential, KSA
(5) Simulating Renewable Energy model for Residential, KSA
(6) Demonstrating result.
(7) Economic Analysis

Technical Approach and Expected Deliverables

- Literature search of the Designing Renewables for Residential
- Understanding Renewable design using simulation.
- Carry out Simulation using simulation tool
- Report with simulated results and discussion
- Report with economic analysis results and discussion

Project # P5

Project Title: Design and Analysis for a Residential Renewable Energy Systems in KSA (2).

Professor(s) Name(s): 1.Dr. Wonsuk Ko 2. Dr. Essam Al-Ammar

Number of Students: Two

Students Qualifications

Students should have good background in renewable modeling and economic analysis.

Statement of Problem

Due to the COVID-19, in this project we are going to only simulate and analysis for a "Design and Analysis for a Residential Renewable Energy Systems in KSA". To design Renewables, first understanding Renewable energy principles and then Load analysis of Residential in KSA. Then investigating regulation of KSA, calculating required power consumption of each household. Finally, simulating and economic analysis of your renewable system.

Brief Description of the Project

This project investigates Residential Renewable Energy Systems for KSA. The unique approach of this project is we need two teams for design renewables, one team researches traditional house as AC based and the other as DC based, and both consider grid off and grid tied.
The objective of proposed project is to design renewables for residential in KSA and understand the install approach in KSA. After designing renewables for residential, economic analysis is required using simulation.

Objectives

(8) Understanding Renewable Energy Principle
(9) Assessment of Current Energy Consumption in Residential, KSA
(10) Load Analysis of Residential, KSA
(11) Designing Renewable Energy System for Residential, KSA
(12) Simulating Renewable Energy model for Residential, KSA
(13) Demonstrating result.
(14) Economic Analysis

Technical Approach and Expected Deliverables

- Literature search of the Designing Renewables for Residential
- Understanding Renewable design using simulation.
- Carry out Simulation using simulation tool
- Report with simulated results and discussion
- Report with economic analysis results and discussion

Project # P6

Project Title: Optimizing energy consumption using an Artificial Intelligence based Controller in Smart Buildings.

Professor(s) Name(s): 1. Dr. Yasser Bin Salamah
2. Dr. Irfan Ahmad

Number of Students: Two

Students Qualifications

Courses: EE 351.

Comfortable working with MATLAB and Simulink.

Statement of the problem and Brief Description of the Project

Recently, due to the high wastage of electrical energy in residential and commercial building, the needs to develop and implement an energy optimization tool gained vital importance. The energy optimization tool is intended to maintain a balance between user comfort and energy requirements. In other words, the goal of the optimizer is to achieve the desired comfort conditions of the users with minimum energy consumption.

Objectives

- To conduct a comprehensive literature review of the problem of energy consumption optimization in smart buildings.
- To develop an AI-based controller that optimizes the energy consumption in smart buildings.
- To validate the proposed method using Simulation tool.
- To conduct experimental validation tests.

Technical Approach and Expected Deliverables

The project will have two main phases.

Phase 1 (1st semester):

1. Conduct a literature review and formulate the problem.
2. Develop an AI-based Controller.
3. Study the suitability of the proposed solution using MATLAB.

Phase 2:

1. To use a more complex (high fidelity) model.
2. Update and implement the design using industrial simulation tool, or,
3. Develop a physical prototype.

Project # P7

Project Title: Design Solar Panel Maximum Power Point Tracking in the Presence of Clouds

Professor Name: Dr. Abdulaziz Alkuhayli

Number of Students: Two

Students Qualifications:

Basic knowledge in Matlab.

Statement of Problem

Nowadays, renewable energy sources are getting a lot of attention, especially solar energy, as it is the cleanest energy source and has the greatest availability compared to other energy sources. Solar power systems or photovoltaic (PV) systems are composed of solar panels, inverter and other electrical and mechanical components. PV systems face several challenges including environmental condition (such as the presence of clouds) as well as non-linear I-V characteristics which results in a unique operating point or optimum voltage at which PV array delivers maximum power for a given environmental condition.

Brief Description of the Project

To get the maximum allowable energy out of a PV system, it must operate at this unique point of the I-V curve, which is known as Maximum Power Point. The aim of this project is to design and simulate a Maximum Power Point Tracking (MPPT) controller for PV systems.

Objectives

(1) Select a MPPT method
(2) Develop and utilize the MPPT controller in Matlab/Simulink.
(3) Test the real time performance of the method experimentally.

Technical Approach and Expected Deliverables

You will develop a testbed to investigate the performance of the MPPT controller.