King Saud University
College of Engineering
Electrical Engineering Department **Semester: 422**

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.** **# P1**

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.

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: Maximum Power Point Tracking for Low Power Photovoltaic Solar Panels

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 MATLAB.

Statement of Problem

Maximum power point tracking (MPPT) is an important part of solar photovoltaic (PV) system. It increases the efficiency of a solar panel by tracking the maximum power point. There are several MPPT control algorithms in use. In this capstone design, four control algorithms are analyzed comparatively.

Brief Description of the Project

This project investigates MATLAB/Simulink a solar PV system with MPPT controlled dc-dc converter, then the efficiency of perturb-and-observe (PO) algorithm, is calculated using typical daily insulation and temperature variation. The perturb-and-observe (PO) algorithm, incremental conductance, fractional open-circuit voltage and artificial intelligence-based algorithms are analyzed and compared.

Objectives

(1) Understanding Solar Energy Principle
(2) Understanding Maximum power point tracking.
(3) Understanding MPPT control algorithm
(4) Applying algorithm to MPPT system
(5) Modeling and simulating MPPT by MATLAB
(6) Analyzing the simulation result.

Technical Approach and Expected Deliverables

- Literature search of the MPPT algorithm
- Understanding MPPT in Solar energy generation system.
- Carry out Simulation using simulation tool
- Report with simulated results and discussion
- Report with results comparison and discussion

Project # P4

Project Title: Design a microprogrammed third order FIR digital filter

Professor(s) Name(s): 1. Dr. Adnan Nouh
2. Dr. Saeed Aldosari

Number of Students: Two

Students Qualifications:
Logic Design
Microcontroller
MATLAB

Statement of Problem

The finite impulse response [FIR] digital filter is a spatial domain filter with a frequency domain representation. The FIR digital filters are used in digital signal processing application. Bandpass, Wiener, and lowpass filters were design and applied to T1 myocardial images. The bandpass filter eliminates low-frequency image components that represents background activity and high-frequency components due to noise.
The wiener filter illustrates the power of the FIR technique to design filters with any desired frequency response.
The goal of this project is to design
a microprogrammed controller for third order FIR digital filter. In this system, there are four coefficients w_0,w_1, w_2, and w_3. The output y (k) is the discrete convolution product of the inputs x(k) and the filter coefficients.
This is formally expressed as follows:

$$Y(k) = w_0x(k) + w_1x(k-1) + w_2x(k-2) + w_3x(k-3)$$

The main components of the circuit include number of registers, Analog to digital converter, Multiplier accumulator, and digital analog converter.

Objectives

The principal objective of this project is to investigate design of a microprogrammed controller for third order FIR digital filter.
A secondary objective is to write a MATLAB program for filter design depending on the user defined specifications.
The aim of the work is to study, analyze and implement two methods for designing the filter controller.

Technical Approach and Expected Deliverable

The technical approach to achieve the above objectives is to study first the different methods of designing FIR filter and the different methods to implement the digital filter including the hardware controller. Two approaches will be used for design of the controller: Hardwired approach and microprogramming approach. Then the two approaches will be simulated and the result will be compared.

The expected end product is the FIR filter controller circuit.