School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg

ELEN 4000/4011 Design II 2018

List of Design Topic 2018

Field of interest: Telecommunications
Title of project: Design of a robust codec for fading channel.

Supervisor: F Takawira

Stream: IE Pre-requisite courses : none

Brief description of content and scope of project:
Design a codec that uses adaptive modulation and coding (AMC). The codec must achieves a rate of at least 2 bits/Hz operating over the ITU Pedestrian-A channel. Your design should specify the following: • Modulation scheme and its corresponding demodulation • A channel encoding scheme and its corresponding decoding. • A scheme to achieve AMC. The chosen modulation/coding scheme must be mathematically described, tested and analysed. Sensible assumptions about transmit frequencies must be made. Matlab simulation results for transmission over the ITU Pedestrian-A channel must be provided.

Field of interest:	Software Engineering

Title of project:	Design of a system for spatial-temporal energy studies on campus

Supervisor:	KJ Nixon

Stream:	both EE and IE	Pre-requisite courses:	None

Brief description of content and scope of project:

There are a number of renewable energy installations on campus such as the grid-tied photovoltaic system at the Genmin Laboratory and solar water heating systems at some residences. To understand how these systems are being used, and how they are performing, it is essential to constantly monitor and measure various aspects of the system. Also critical is the data integrity of these measurements and that no data is ever lost due to power outages or communication network issues.

This project will involve designing a software system for energy monitoring, analysis and visualization of energy systems on campus. The framework should allow seamless visualization and integration of existing and future energy systems. It is essential that any data is correctly time-stamped, and also has geolocation information.

An important outcome of the design will be a minimum viable product (MVP).

Field of interest: Renewable Energy

Title of project: Dimensioning the storage for a renewable energy hybrid system

Supervisor: Prof. W.A. Cronje

Stream: both EE and IE Pre-requisite courses (if any):

Brief description of content and scope of project:

Based on consumption pattern data for a particular application/site, design a reasonable energy storage facility, if a micro wind-turbine and a small photo-voltaic array are available as sources of renewable energy. The fluctuations in the availability of the renewable energy sources have to be taken into account.

A cost analysis has to be done for the system in order to arrive at a reasonable commercially acceptable system.

Field of interest:	**High Voltage**

Title of project:	**Modelling transient voltage stresses in wind farm step-up transformer windings and designing the winding insulation appropriately**

Supervisor:	**John Van Coller**

Stream:	**EE**	Pre-requisite courses:	**ELEN4003**

Brief description of content and scope of project:

In wind farms where step-up transformers are located close to vacuum switchgear the transformer will be subjected to a voltage surge many times in one day each time the switchgear is operated. These transformers then fail because the insulation is not adequately designed to withstand these repetitive surge voltage stresses.

This project will involve modelling the 33 kV winding of a 690V / 33 kV three-phase 2,7 MVA step-up transformer when subjected to a voltage surge. The models that will be used are extensively described in the literature. The students will then look at the transient strength of oil/paper insulation and make recommendations on the required thickness of the oil/paper insulation

As part of the Design, the students will visit a transformer factory in the Gauteng area to gain greater insight into the geometry of MV/LV transformer windings.

Field of interest: Electronics

Title of project:
Reduced energy buffering requirements

Supervisor: I Hofsajer

Stream: both EE and IE Pre-requisite courses: none

Brief description of content and scope of project:

In many single phase inverter applications there is a low frequency mismatch between the input power and the output power. Consider a solar inverter fed from 400V DC and outputting 230V RMS at 50Hz. The output power is pulsating and ideally the input power should be constant.
To solve this mismatch a large electrolytic is normally capacitor placed across the DC supply and sized in such a way to limit the ripple on the DC voltage to a certain amount. The problem with this approach is that the DC capacitor is huge. It carries a constant energy and well as the useful fluctuating energy.

It is proposed that the DC capacitor can be decoupled from the DC bus by means of a bidirectional power converter. The converter has the objective of keeping the DC bus constant and does this by storing and injecting energy into the DC capacitor. Because they are decoupled, the voltage across the capacitor can now vary by a large amount, and a much smaller capacitor can be used.

In this project a stable DC bus will need to be designed for a solar inverter. The objective is to minimize the total volume of the DC bus components. The size of the conventional capacitor will need to be traded off for the size of the bidirectional converter and smaller capacitor.
This will entail:
Topology selection and control algorithm. (no feedback control is required)
Modelling of capacitor voltage and volume.
Loss modelling of the converter.
Optimization of the system to lead to minimum volume.
The system will need to be rigorously validated in a simulation environment.

Field of interest: Biomedical Engineering, Systems Design and Signal Processing

Proposed title of project: Design of a low-cost adaptive hearing aid.

Supervisor:
D Rubin

Stream: IE, EE, BME

***Note**: The group that gets the hearing aid project for their laboratory project is excluding from taking this project*.

Pre-requisite courses:
All relevant undergraduate courses.

Brief description of content and scope of project:

Conductive hearing loss affects millions of people world-wide. The development of a low-cost hearing aid with substantial functionality may greatly assist people who would otherwise not have access to such systems. The project requires you to develop a system-level design of a pair of hearing aids which are able to detect sound, do preliminary signal conditioning and filtering, ADC, digital signal processing and amplified sound production. The research will require the user to fully understand the key elements of hearing aids, viz. the device must differentially amplify sounds across the auditory frequency band based on the individual's audiogram for that ear. In addition, a directional component must be included such that the signal detected by the two hearing aids must be utilised to achieve the required directionality.

The design must involve a full specification followed by a systems-level design and a detailed description of the algorithms by way of flow-charts and pseudocode as required. A cost analysis is essential with comparison with equivalent systems.commercially available hearing aids.

Field of interest:
Antenna Design

Title of project:
Antenna Array Design to map man made space "junk" in low earth orbit

Supervisor:
Dr. Renier Dreyer

Stream:
EE

Pre-requisite courses:
HF Techniques

Brief description of content and scope of project:

With the increase in space travel, it is becoming more and more important to know where potentially fatal problems may arise due to man made space junk/debris.
The man made space junk is made of small objects travelling at high velocity, (usually metalic). This occurs due to bits and pieces breaking off from satellites, rockets, space stations, intentional satellite destruction by missiles etc.
This was highlighted in the movie "Gravity"
Startup companies such as LEOLABS (www.leolabs.space) have begun to address this problem.
Students will be required to do a theoretical design similar to LEOLABS phased array radars in order to track space debris, including the operational environment and costing of the system.
FEKO will be made available to the students in the DLAB to run simulations.
A visit factory visit to Alaris antennas will be organised to ask questions of engineers in industry. (week 3 or 4)

Field of interest:
Systems and Control Engineering

Title of project:
Design of a Roll-Stabilising Controller for Container Ships

Supervisor::
Prof MA van Wyk

Stream: **Both**
Pre-requisite courses: **ELEN3016 (Control I)**

Brief description of content and scope of project:

Under extreme conditions at sea several different types of ships including aircraft carriers, passenger-car ferries, cruise ships and cargo carriers, are prone to ship-roll which could induce catastrophic resonance. Resonances, by nature, result in large amplitude oscillations. In the case of a sea faring vessel this can cause roll angle amplitudes of as much as 50 degrees which are usually fatal for the survival of the vessel as well as its cargo.
The main objective is to design a simple controller to reduce/eliminate the problem of ship-roll for a container ship. The project consists of two main phases namely a project definition and planning phase followed by a ship-roll modelling, design, implementation and test phase.
The first phase starts with a vague description by the client from which a user requirement specification and a detailed project performance specification and plan need to be developed with the project term of 6 weeks in mind. This will provide the context for the second phase of the project.
As output of the second phase a simple elegant solution that works will be preferred over an advanced approach that results in various kinds of difficulties and perhaps never work successfully.
The final design is required to be implemented and tested using some simulation language/environment (e.g. Matlab, octave, FreeMat, Julia, etc.).