School of Electrical and Information Engineering
University of the Witwatersrand, Johannesburg
ELEN4002A – Electrical Engineering Laboratory
ELEN4012A – Information Engineering Laboratory

Course Brief and Outline: 2019

Academic Staff

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1 Course Background

The Electrical/Information Engineering Laboratory is one of two "capstone" courses of the BSc(Eng) Programme. Successful performance in this course calls for experience in laboratory and investigative work and the application of knowledge acquired by the student during the BSc(Eng) programme. Well developed problem solving and communication are key elements in the course.

2 Course Objectives

The objective of this course is to assess the ability of a student to undertake a significant investigation that involves the research, design, implementation and investigation of a system, product, prototype or process, typical of a complex engineering problem. This will require engineering knowledge and problem solving, using analysis, synthesis and performance evaluation methods. The knowledge required to complete the investigation will be both fundamental as well as special to the topic at hand, and will require independent study.

3 Course Outcomes

On successful completion of this course, the student is able to:

- complete under limited instruction and supervision a significant engineering study that requires actual observations to be reconciled with the conclusions of reasoning from theories or engineering concepts appropriate to the study;

- apply in a scrupulously rigorous manner, the principles of systematic quantification (measurement) or verification;

- communicate the study approach, experiments, observations and conclusions at a level and in a form expected of an entrant to the engineering profession.

The study is to be carried out in a context similar to an engineer at the entry level to the profession, performing and reporting to an experienced engineer who would take decisions based on the report. Professional engineering values apply. In particular, the student is required to satisfy the Engineering Council of South Africa (ECSA) Exit Level Outcomes (ELOs) as indicated in Table 1.

Failure to perform at less than an acceptable level in any of the outcomes will result in outright failure. The student will then need to repeat the course in the following year.

Table 1: ECSA Exit Level Outcomes (ELOs)

ELO	Description of the ELO
1	Solve problems using analysis, synthesis and evaluation at various levels, including complex engineering problems.
2	Use specialist and fundamental engineering knowledge, supported by mathematics and natural sciences, in the solution of engineering problems, including a complex engineering problem.
4a	Design and conduct an investigation of an engineering problem that has the characteristics of a complex engineering problem.
4b	Design and conduct an experiment in the context of a complex engineering problem investigation and reconcile observations with predictions.
5	Select and effectively use appropriate tools and methods for the problem under investigation.
6a	Report on the investigation in the form of a technical paper that meets typical journal format requirements.
6c	Prepare and deliver an oral presentation, supported by visual aids, on an investigation to a peer audience.
8b	Work effectively as a member of a team.
9	Source, evaluate and correctly use knowledge and methods that are new to the student.

4 Course Content

The course requires students to undertake a significant engineering study under limited supervision, involving aspects such as background research, planning, implementation, testing, critical analysis and the communication of the findings and results of the study.

5 Prior Knowledge Assumed

Students are required to call on fundamental knowledge gained during their undergraduate curriculum. Some projects may have additional prerequisite conditions.

6 Assessment

The forms used to assess the performance of each student will be made available with the Course Brief and Outline.

6.1 Formative Assessment

The formative assessment contributors are:

1. Each student is required to form a group, obtain bidding rights and engage in the bidding process.

2. Each group of students is required to prepare a poster for the School Open Day explaining their project.

3. Each student is required to record their activities and progress in an engineering notebook which must be available on request for inspection by the project supervisor or examiners.

4. Each student is required to attend and to chair formal meetings as well as record minutes and agendas of the meetings to be submitted at the conclusion of the project.

6.2 Summative Assessment

The primary focus of the assessment of the laboratory project is to ensure that the student meets the required Exit Level Outcomes as defined by the Engineering Council of South Africa. This is achieved by defining key contributors and outcomes and assessing the performance of each student as being one of *Deficient*, *Acceptable*, *Good* or *Excellent* (see Table 2). A rating of *Deficient* in any Exit Level Outcome will result in an overall failing mark for the course.

Table 2: Qualitative assessment mapping

Rating	General Interpretation
Deficient	One or more major flaws.
Acceptable	No more than minor flaws, otherwise complete; no distinguishing features.
Good	Shows insight; some distinguishing feature(s).
Excellent	Exceptional insight and multiple distinguishing features.

The summative assessment contributors are:

1. a *joint* **Specification Outline** submitted by each group of students.

2. a *joint* **Project Plan** submitted by each group of students.

3. an *individual* **Project Report** (short paper with appendices) that reflects the own work of the student, except where contributions of others are incorporated and duly acknowledged.

4. a *joint* **Presentation** delivered by each group of students that summarises the objectives, approach and key findings of their laboratory project. Each student is assessed individually, although some components of the presentation assessment assess teamwork.

5. an *individual* **Interview**, attended by both the internal and external examiners as well as a facilitator. This is scheduled after the written project report has been assessed and the students have made their presentations. The outcome of the interview will be used in finalising the assessment of the project report and presentation. This may result in the overall result being modified, particularly in borderline cases or where doubt exists as to the exact contribution of each group member to the project.

Table 3 shows the contribution to the final result of each summative assessment contributor.

Table 3: Summative assessment contributions

Assessment Contributor	Duration (hours)	Component	Method & Weight	Calculator Type	Permitted Supporting Material
a) Project Planning					
i) Specification Outline	16	No	Rubric - 5%	-	-
ii) Project Plan	32	No	Rubric - 10%	-	-
b) Project Report	300	No	Rubric - 65%	-	-
c) Presentation	8	No	Rubric - 20%	-	-

* The notional hours for project report includes the time spent completing the project as well as writing the final report.

Assessment will address the essential performance items listed in the Course Outcomes (*Section 3*). The student must demonstrate at least an Acceptable level of performance as defined in Table 2 in the Exit Level Outcomes listed in Table 1. Failure to demonstrate this level of performance, or above, in any outcome results in a failing overall mark. See *Section 6.3* for detail.

All submissions must be in strict accordance with the guidelines contained in the *School's Blue Book* and the rules contained in the *School's Red Book*. No exceptions will be considered.

6.3 Assessment Methods

Assessment of the student is carried out chiefly on the basis of the project report and presentation. The project supervisor (internal examiner) will, in addition, have monitored progress during the project.

The assessment process is as follows:

1. The submitted project reports are assessed by the internal examiner. The student's performance in specific outcome areas is rated using the assessment form. Any comments are recorded.

2. The external examiner also receives the project reports. The external examiner independently assesses the reports according to the assessment form, without any knowledge of the internal examiner's assessment.

3. The internal, external and facilitator attend and assess the student presentations. After the presentations, the group of examiners conduct the individual interviews with the students at their place of work. Any important observations are recorded.

4. The group of examiners then convene to finalise the assessment. This involves discussing and resolving any disagreements between internal and external with the assistance of the facilitator. Based on the individual interview, the group of examiners may adjust the overall assessment to more accurately reflect the student's performance. Through this process, the group of examiners consider whether or not the exit level outcomes defined by the Engineering Council of South Africa (ECSA) have been met satisfactorily. If not, the student **cannot pass the course** and the examiners must provide an explanation and a recommended course of action. Once everything has been finalised, the internal, external and facilitator sign the "Assessment Form" which is then returned to the course coordinator. Any late submission penalties that have been incurred are then applied to overall assessment by subtracting the appropriate amount of percentage points from the final mark.

The examiners will use the assessment form to determine the overall performance of the student. The final, overall assessment is restricted to one of four possible ratings ranging from *Deficient* to *Excellent*. The student will fail the course if they receive an overall assessment of *Deficient*. An overall assessment of *Deficient* will result if the student fails to achieve one (or more) of the ECSA Exit Level Outcomes, or if the student does not meet the satisfactory performance requirements.

7 Satisfactory Performance (SP)

For the purpose of Rule G.13 *satisfactory performance in the work of the class* means that each student:

1. actively attempts to find a group partner and form a group;

2. obtains bidding rights on projects by meeting, in person, with prospective supervisors;

3. participates in the bidding process by placing project bids;

4. meets with the project supervisor to discuss the write-up and requirements of project planning;

5. provides regular feedback on project progress at group meetings.

Failure to do one of the following without a valid medical excuse will result in failing to meet one or more of the outcomes for the course (see Assessment Form document): submit project planning reports, and a final report, be present on the open day, and present at the laboratory project conference. Exemption for any component of the course will generally only be considered on medical grounds.

All students **must** be available **full-time** during the entire duration of the project and are required to meet weekly with the project supervisor. Failure to do so will result in one or more outcomes for the course not being met.

8 Teaching and Learning Process

8.1 Teaching and Learning Approach

The course is project-based and therefore largely self-guided with limited supervision.

8.2 Information to Support the Course

Under their own initiative, students are expected to read and consult as widely as possible in completing the investigation. It is very important that students demonstrate independent learning ability by making use of the library and credible sources to gain the required background information to complete the investigation.

8.3 Learning Activities and Arrangements

This is a capstone course that involves an investigative laboratory.

Students form groups of two, bid for, and are allocated, projects from the list of available projects. Work should start on the project as early as possible, and consistent effort and progress is expected throughout the year.

Students prepare the first part of the project planning which details the full project specification, project milestones, risks and required resources. Students then prepare the second part of the project planning which details the implementation of the project, including testing methodologies, and the management of the project. These are both group report submissions.

The main investigation is carried out on a full-time basis over an eight-week period commencing around the start of the third teaching block. At the end of this period students submit their final report along with all associated documentation.

Students then present their work, at the laboratory project conference, to both the internal and external examiners and the facilitator. Students are individually interviewed and the final mark is agreed upon.

Announcements regarding the course will be communicated via the fourth year mailing list. Refer to the *Key Dates for 4th Years - 2019* document published by the School for key dates and deadlines related to this course.

The following sections contain more detail regarding the arrangements for the course.

Forming Groups

A requirement of the course is that projects are undertaken by groups of **two** students, except in the case where there is an odd number of students taking the course, where there will be exactly **one** group of three students. Each student is expected to make a substantial contribution to the execution of the project, which must be reflected in their participation, project papers and interviews. Note that there are special conditions that apply to groups containing **repeat students** (see *Section 10.3*).

Project Proposals and Bidding

1. Supervisors prepare a number of laboratory project proposals across the spectrum of Electrical and Information Engineering. A limited number of projects will be prepared in order to ensure a fair work-load distribution amongst the supervisors. Each supervisor will supervise two to three projects only. Only in **exceptional** cases may a supervisor offer more than three projects.

2. Groups may propose their own projects provided that no group member is a repeat student. Refer to *Section 10.1* for details regarding the scope and complexity of the project. In this case, a supervisor within the School must agree to supervise the project. Note that each supervisor is only permitted to supervise **one** student proposed project. Additionally, the project proposal must be submitted to the School before the published deadline. Note that **no** student proposed projects will be accepted after this deadline under any circumstances.

3. A list of descriptions of available projects will be posted by a particular date.

4. Groups are required to arrange meetings with prospective supervisors in order to "bid" for a project. Supervisors will be available for two weeks for this. In the event that a supervisor is not available during the two weeks another academic staff member will be tasked as a stand-in supervisor.

5. Bidding for projects is open for one week.

6. The students must have met with at least three project supervisors and nominated first, second and third choice projects before the published deadline.

7. Notification of final project allocation will be given before the end of the first block.

Project Allocation

Due to the finite number of project supervisors and resources available within the School, there is a bidding process that is followed when allocating projects to students. This bidding and allocation process is described in more detail on the course homepage.

Several important points must be noted with regards to this process:

- The process is designed to be as fair and transparent as possible. Students are encouraged to arrange a meeting with the course coordinator to seek clarification on any decisions or if there are any questions about the process.

- *Where possible*, the allocation algorithm will allocate students their first choice of project. However, some projects will be popular and have competing first choice bids. In this case, only one of the first choice bids will "win" the project. The remaining students will be allocated their second or third choice.

- Students who have placed all of their bids for popular projects may not be granted any of the projects that they have bid for. In these circumstances, the course coordinator, in consultation with the Head of School, will allocate the remaining projects to students, matching the students' selection as far as possible.

The School reserves the right to withdraw or alter project proposals should circumstances require such.

The process of choosing partners, viewing and bidding on projects, and notice of the final project allocation will all be available online on the course homepage.

Preparation of Project Planning

Students are expected to meet with supervisors to discuss the the project planning requirements during the first semester study break and again during the June/July vacation. Also refer to *Section 10.2*.

Full-Time Commencement of the Project

The project supervisor will make arrangements regarding consultation times and the use of School facilities with each group individually. Projects **must** be completed on the University premises. ICAM access to **all laboratories** (except the Computer Laboratory) will only be granted during working hours (08h00 to 16h30) when laboratory technicians are present. This is due to safety considerations and is in accordance with the national Occupational Health and Safety Act. No exceptions will be considered.

All students are required to administer and attend formal meetings during the course of the project. These meetings will be held at least once a week (possibly as part of a related School research group meeting). The minutes and agendas of the formal meetings must be submitted at the conclusion of the project, as part of the final submission.

Final Report Submission

The project report and associated documents must *all* be submitted electronically before the published deadline – if any component is late the overall penalty will be determined based on the submission time of the last component (refer to the *School's Red Book*).

All submissions related to this course must be made using the University's eLearning system (Sakai). No e-mail or other submissions will be accepted.

If a student has completed their project planning reports or project report at least a week before the hand-in date, then the supervisor may provide the student with some high-level feedback (no detailed feedback will be given), but this remains entirely at the discretion of individual supervisors.

Conference Presentation and Interview

The following points summarise important information about the conference:

- Students must be available at least 15 minutes prior to the start of their session.

- Each project group will give a 15 minute joint presentation - time shared equally between the two students. If, for whatever reason, a member of a group is not available on the day of the student presentations, the remaining member will still deliver their presentation and will not be penalised in any way. In this case, the single student will be allowed 10 minutes to deliver their presentation. A student who misses the presentation session due to a valid medical reason will still be required to present their work at an alternative time. A group of three students will be allocated 23 minutes for their presentation.

- Five minutes will be permitted for informal questioning from the conference audience, if necessary. This time will also be used for hand-over and setup for the following group.

- Students must give an electronic presentation.

- Each session will have the project supervisor and external examiners present. Each session will also have a session chairperson, who will serve as a facilitator for the individual appraisals.

- There will be a time period allocated between each session to allow for individual student appraisals. The individual appraisal permits the examiners to make adjustments (if necessary) to a student's results based on one-to-one interaction and discussion. The appraisal also allows the external examiner to view the work location of the student if they wish. Each student in the group is interviewed separately by a panel of three, consisting of the External Examiner, the Supervisor (Internal Examiner) and a Facilitator. Following the interview, the panel reviews the student's marks and comes to a final decision.

- Students are welcome to attend their fellow students' presentations.

An explanation of the assessment of the project reports and presentation is contained in *Section 6.2* and *Section 6.3*.

9   Course Homepage

`http://labproj.eie.wits.ac.za`

10   Other Information

The following sections contain important supplementary information to support the course.

10.1   Project Scope and Complexity

Project supervisors and student groups proposing projects are required to compile and outline problem specifications for the study that satisfy the following requirements:

1. Requires significant investigation and/or quantification.

2. Contains a mix of practical constraints and uncertainties.

3. Presents a substantial challenge.

4. Requires critical analysis and observations to be made that can be reproduced.

5. May require the construction and evaluation of a prototype or the preparation of software.

6. Places emphasis on the investigation, **not** the development of tools for the investigation, though this may be required.

7. Requires some knowledge at final-year level, but not necessarily contained in formal courses.

8. Is capable of being completed, including documentation, with a commitment of full-time work of approximately eight weeks.

9. Provides an intellectual challenge, while at the same time not be so extensive that there is no time to do justice to the study.

10. Provides and requires scope for verification and validation of the outcome, product or results of the project.

10.2   Documentation Requirements

The detailed structure and style of documentation will conform to current practice in the particular sub-discipline. A number of generic requirements exist and apply to all laboratory project reports:

1. The reports must include an analysis of the problem and a clear statement of the study objectives;

2. The logical approach to the study and, in particular, the identification and planning of experiments and observations must be presented;

3. A critical review of the literature must be presented;

4. The experiments and observations must be described in sufficient detail so that they can be reproduced and verified;

5. A critical assessment of the results achieved and of the overall project must be presented;

6. Graphs, tables, diagrams and other illustrative material are an important part of the presentation and must be clear and in a satisfactory format;

7. Detailed information may be presented in a format prescribed in the problem specification. Where no format is prescribed, information must be presented in a clear and accessible way;

8. The completed documentation and presentations must be concise and of a high standard, in accordance with accepted guidelines for report writing and presentation delivering that apply within the School of Electrical and Information Engineering.

Project Planning Requirements

The two components of the project planning reports are both group submissions. The reports should detail the overall project description, milestones, risks and required resources as well as the implementation and project management of the project. Groups will be required to present the project plan at the start of the laboratory project.

Risks may arise from a number of sources, including:

- occupational health and safety hazards,
- ethics contraventions,
- intellectual property infringement,
- IT security risks, and
- project dependencies (people, data, or equipment) which become unavailable.

Project Report Requirements

The project report is an individual report — group members may not have overly similar reports. The project report must take the form of a short paper with appendices. The report should be four to six pages in length and it should conform to the paper template given on the course homepage. The first appendix, of no more than two pages, must be a reflection on working as a group. The second appendix must be the original, unmarked Project Specification Outline. The third appendix must be the original, unmarked Project Plan report. Additional appendices may be supplied as required. Refer to "Paper Guidelines" document for more information.

10.3 Repeat Students

Several important conditions must be noted for students repeating the course:

1. A repeat student may **not** have the same project supervisor twice under any circumstances.

2. A repeat student may **not** have the same group partner twice under any circumstances.

3. A repeat student may **not** work on the same project (even with modifications).

4. A repeat student **must** be available **full-time** during the eight weeks of the project and will be required to meet weekly with the project supervisor. Failure to do so will result in SP requirements not being met and the student will fail the course.

5. A repeat student who is employed must furnish the School with a letter from their employer confirming their full-time availability.

10.4 Budget

Each group is allocated a budget for items required for their project, such as books, electronic components and so on. Before purchasing any new items it is important that the group discusses the purchase with their project supervisor. Additionally the group must ascertain whether or not the items can be supplied directly by the School's workshops.

Any expenditure must be approved in writing by the project supervisor. Generally, supervisors will generate internal purchase orders for any items required by the student. It is important that the students allow enough time for these requests to be processed. All items purchased remain the property of the school (refer to *Section 10.5*).

The School will provide a limited budget for the production of posters.

10.5 Project Artefacts and Intellectual Property

Hardware and software artefacts produced or purchased during the final year laboratory project remain the property of the School of Electrical and Information Engineering. Students may not remove these artefacts upon completion of the course without written agreement of the Head of School.

All material produced during the laboratory project is governed by the University's Policy on Intellectual Property – available online from the Registrar's Help Desk.