Course Brief and Outline – 2017

Course Co-ordinator:

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1 Course Background and Purpose

1.1. ECSA requirements

As a fourth year course, a number of ECSA "Exit level outcomes" are assessed as shown in table 1.

1.2. School requirements

This course is presented as a bridge between the subjects of the previous three years and the design and laboratory projects. Although sensors and conditioning elements are covered, the main emphasis is on analysis, visualisation and modelling of measurement systems.

2.1 Course Outcomes

To successfully complete this course a student will have to demonstrate the ability to design, analyse and model complex measurement systems using the following skills:

- analysis of a measurement system and identification of important and critical components,
- calibration of a measurement system and the concept of traceability,
- identify, analyse and rectify:
  i. the effects of deterministic or systematic errors in a measurement system,
  ii. random error in a measurement system,
  iii. dynamic errors in a measurement system,
  iv. the introduction and propagation of noise in a measurement system.

- application of bridges, instrumentation amplifiers, analogue to digital (A/D) converters and various transducer technologies in measurement systems.

Table 1: ECSA requirements

Outcome	**Assessment**	**Satisfactory Performance**
Identify, assess, formulate and solve convergent and divergent engineering problems creatively and innovatively.	**Exam:** Unseen topic new to student. **Project:** Topic new to student	Exam: Pass mark. Project: Successful completion of the project that is assessed against a problem solving framework

		(see section 6.2)
Apply knowledge of mathematics, basic science and engineering sciences from first principles to solve engineering problems	Successfully uses mathematics, physics and variety of basic engineering sciences, with the required integration of knowledge, to solve problems in the examination, laboratory assignments and project	Successfully completing the examination, laboratory assignments and project
Demonstrate competence to: 1. Use appropriate engineering methods, skills and tools and assess the results they yield. 2. Use computer packages for computation, modelling, simulation, and information handling.	Uses MATLAB, OCTAVE, SPICE etc for modelling, simulation, processing data. Calibrates instruments. Performs Error analysis	The student must demonstrate proficiency in the use of specialist software in the project. Failure to demonstrate this proficiency will result in failure of the project and failure of the entire course **(see Rule G13)**
Communicate effectively, both orally and in writing, with engineering audiences and the community at large, using appropriate structure, style and graphical support.	The project report and oral presentation is assessed against the communication outcomes (section 6.2) as part of formative assessment	Successful completion of the project

2.2 Course Content

Instrumentation systems concepts and terminology. Static and dynamic properties of measurement systems, calibration. Introduction to statistical techniques for handling measurement uncertainty. Noise. Transducers based on varying R, L, C. Signal conditioning. Thermocouples, piezoelectric transducers.

2.2 Prerequisites

ELEN3002, ELEN3007, ELEN3012, ELEN3016

3 Course Details

Instrumentation systems concepts and terminology. Static and dynamic properties of measurement systems, calibration. Introduction to statistical techniques for handling measurement uncertainty. Noise. Transducers based on varying R, L, C. Signal conditioning. Thermocouples, piezoelectric transducers.

4 Prior Knowledge Assumed

All 1st, 2nd and 3rd year electrical engineering courses with emphasis on Physics, Signals and Systems, Electronics, Software and Control.

5 Assessment

5.1 Components of the Assessment

See Rule G13 on the School notice board.

Please note: As the requirements are outcomes based a student must successfully complete and pass all components, namely Exam, Laboratory and Project and also fulfil all the outcomes in **Table 1**.

Failure of one or more components will result in failure of the entire course.

5.2 Assessment Criteria

Laboratories and Project: Students must perform set experiments, answer questions posed and hand in short reports by the stipulated deadlines. One of the labs will be of greater extent. Projects are also performed in groups of two but reports are written on an individual basis. Laboratory exercises can be worked on and orally marked in pairs but written submissions are to be done individually. Oral presentations shall be done as part of the "workshop" type lectures and marks shall be allocated to these oral presentations. See details in the Lab and Project Briefs.

Examination: Tests fundamental principles, where emphasis is placed on design, application and analysis as opposed to regurgitation of bookwork.

Important: Plagiarism from any source is prohibited and will result in disciplinary steps in accordance with the relevant university policy.

5.3 Satisfactory Performance (SP) Requirements

See Rule G13 on the School notice board.

In addition, the successful completion of the laboratory and project assignments are SP requirements. This rule will be strictly applied. No students (including repeats) will be exempted from the laboratories.

5.4 Calculators in Examinations

See Rule G13 on the School notice board.

6 Teaching and Learning Process

6.1 Teaching and Learning Approach

The lectures are run as "workshops" and not the traditional "supply students with information" approach. This is because all the information for the design and analysis of measurement systems is available in data books, web sites and the prescribed text book. What will be discussed is the philosophy and design approach used in developing, analysing and modelling measurement systems with specific emphasis on student originated discussions. To enable students to cope with the "workshop" approach the first few lectures will discuss the modelling of measurement systems. Students are required to bring the prescribed text book (see section 7.1) to the lectures.

Students are required to provide input to the lecturing process and stay concurrent with the topics.
Note: The main content of the lectures will be to discuss project related concepts and problems and marks shall be assigned to the oral presentations presented by the students.

6.2 Arrangements

Lectures:
Two lectures per week (double period) plus one (single period) for self-study which may be used (at the discretion of the lecturer) for a lecture or a tutorial. The use of the self-study period for a lecture/tutorial will be announced verbally during the normal lectures. Printed course notes are not handed out. Students are expected to attend all lectures, understand the lecture material and make their own notes.

Tutorials:
There are no formal tutorials for this course, but students are advised to do the problems at the end of the relevant chapters in Bentley.

Laboratories:
See Lab Brief that will be handed out.

Project:
See the Project Brief that will be handed out.

The project will be assessed, as required by ECSA, against a problem solving framework where the student

- Identifies requirements, success criteria and constraints.
- Gathers, structures and assesses information.
- Performs required analyses.
- Applies knowledge.
- Uses appropriate methods, skills and tools
- Evaluates options critically and with judgement.
- Assesses the impact of the proposal.
- Communicates the logic and outcome of the work which will be assessed as follows:
  - Planning and structure of technical report.
  - Selection of material and accessibility of logic behind the report
  - Style and use of English
  - Accessibility of detailed study information

- Use of drawings, diagrams, tables, graphs and illustrative material
- Impact

Satisfactory assessment requires that the student must produce a complete solution with, at most, minor flaws.

The School's policy on timely submission of projects and assignments will be enforced.

7 Information to Support the Course

7.1 Prescribed Textbook

Bentley, J. P., Principles of Measurement Systems, 4th ed., Harlow, England: Pearson, 2005

7.2 Further Reading

Considine, D.M., *Process Instruments and Controls Handbook*, McGraw-Hill, 1974.

Doebeline, E.O., *Measurement Systems: Application and Design*, 4th Ed., McGraw-Hill, 1990.

Dally, J.W., Riley, W.F. and McConnell, K.G., *Instrumentation for Engineering Measurements*, John Wiley, 1984.

7.2 Course Home Page

Further information and announcements regarding the course is posted on the course home page at http://dept.ee.wits.ac.za/~nyandoro/elen4006.html.

All students are expected to consult the course home page at regular intervals.

8 Other Information

8.1 Course Home Page

Further information and announcements regarding the course will be communicated either via the 4th year notice board, verbal announcements or printed material distributed during lectures or posted on the course home page.

All students are expected to consult the notice board and the course homepage at regular intervals