Course Brief and Outline – 2020

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1 Course Background

Control system design has become a very specialised discipline. Modern control system design developed over the years as our fundamental understanding of real systems improved and today requires knowledge of advanced mathematics and specialised mathematical procedures. This course therefore exposes the student to advanced system modeling and analysis. A range of systems is chosen to give the student a wide exposure to a range of system analyses. Similarly a variety of mathematical approaches and techniques are introduced to allow the student to become versatile with system analysis and thus become a complete engineer.

2 Course Objectives

The primary objective of this course is to provide the student with fundamental techniques to design and implement control systems for linear and non-linear uncertain systems/processes. It is envisaged that this course will lay the necessary foundations for both postgraduate studies and industry related design work.

3 Course Outcomes

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

1. Model physical systems for the purpose of simulation and control system design.
2. Simulate the behaviour of physical systems in MATLAB.
3. Understand the basic principles of modern methods such as state space modelling, linearization, optimal control and intelligent control.
4. Use these modern methods to design control systems.

4 Course Content

The course consists of five sections:

4.1 State Space Methods for Control System Design

Aspects that will be studied include:

- Solution of the state vector differential equation
- Control of multivariable systems – controllability and observability
- State feedback and state observers

4.2 Optimal and Robust Control System Design

Aspects that will be studied include:

- Types of optimal control problems
- The linear quadratic regulator
- Linear quadratic Gaussian control system design
- Robust control techniques

4.3 Intelligent Control System Design

Aspects that will be studied include:

- Fuzzy logic systems
- Neural networks
- Genetic algorithms

4.4 Non-linear Control System Design

Aspects that will be studied include:

- Mathematical description of non-linear systems
- Non-linear phenomena
- Control of non-linear systems

4.5 Advanced Modelling

Aspects that will be studied include:

- Principles of Calculus of Variations
- Discrete System Analysis
- Applications

5 Prior Knowledge Assumed

The following prior knowledge is assumed on the part of students starting this course:

The prerequisites and co-requisites to register for this course are defined in the current *Rules & Syllabuses: Faculty of Engineering and the Built Environment*.

6 Assessment

6.1 Formative Assessments Elements

Tutorial questions, home work assignments and class examples shall be used to provide students a reference of where their understanding should be as the course progresses.

6.2 Summative Assessment

Table 1: Summative assessment contributions

Summative Assessment Contributor	Duration H	Component Yes/No	Method & Weight %	Calculator Type 0/1/2/3	Permitted Supporting Material
Examination	3	No	50	1	A4 Handwritten Sheet
Course Project	20	No	20		
Laboratory Exercises	30	No	30		

6.2 Assessment Methods

The project requires a formal report to be produced according to the guidelines of the School. See *Blue Book*, if you don't have a copy, get one urgently. A lab brief and project brief will be handed out with details of assessment of the lab and project.

7 Satisfactory Performance (SP) Requirements

For the purpose of Rule G.13 *satisfactory performance in the work of the class* means attendance and completion of and submission of prescribed laboratory and project activities, attendance at tutorials designated as compulsory in this CB&O, submission of assignments, writing of scheduled tests unless excused in terms of due procedure.

8 Teaching and Learning Process

8.1 Teaching and Learning Approach

The emphasis of this course is on analysis and design. The necessary foundation material will be covered in lectures. However students must do their own independent background reading (and tutorial work) to consolidate their knowledge. Students are expected to keep up to date, and where possible, prepare for lectures.

Students are expected to do a significant amount of lab work for the laboratory and project assignments. Demonstrator(s) will be available by arrangement during the allotted lab time or by arrangement to assist with the labs but emphasis will be placed on the students own work and research.

8.2 Information to Support the Course

- **Prescribed Textbook**

  Roland S Burns, *Advanced Control Engineering,* Butterworth-Heinnmann Publications, 2001, ISBN: 0-7506-5100-8

- **Further Reading**

  Highly recommended texts are:

  - T. Marwala*, Computational Intelligence for Modelling Complex Systems*, Research India Publications, 2007, ISBN: 978-81-904362-1-2
  - C. M. Bishop, *Pattern Recognition and Machine Learning.* Springer (2006), ISBN 9780387310732.
  - MA van Wyk, W-H Steeb, *Chaos in Electronics*, Kluwer Academic, 1997.

8.3 Learning Activities and Arrangements

Lectures: Two 45-minute lecture periods a week, over the duration of the first semester, will be provided. Students are required to work on their own outside the normal lectures to better understand the material.

Tutorials: The tutorial slot will be by prior arrangement with the lecturer and/or tutor.

Project/Assignment: A design project specification will be provided in written form and the hand-in date is as scheduled and stated in the document entitled School's Key Dates (of which you should have a copy). The School has a strict policy for late hand-ins (please familiarise yourself with this in order to avoid disappointment).

Laboratory: Two afternoons a week are set aside for laboratory and project work. A laboratory assignment specification will be provided with the related due dates for the various assignment sub-components.

Consultation: Consultation is by prior arrangement through email or telephone calls. The lecturer shall be available during lecture breaks and immediately after the lecture. Additional material and course notes will be provided in lectures. Occasionally material will be made available on the course home page.

9 Course Home Page

Further information and announcements regarding the course are posted on the course home page:

http://dept.eie.wits.ac.za/~nyandoro/ControlII

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