MEC3205: Control Systems Engineering

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	30	00	60	100	60	40	4

Rationale

Mechanical engineers should have the ability to mathematically model mechanical systems in order to determine their behavior when subjected to real time situations. In this way by the time the physical system is built it has already been tested mathematically. This course has as its prerequisite Dynamic systems engineering. It takes a system as a black box where the student is only concerned with the input to and the output from the box. The course develops the ability of a student to determine the behavior of a system with respect to stability, errors, disturbances and migration of poles and zeros and then design a controller for the overall system to suit the objectives set out prior to design.

Objectives

- To develop an understanding of the concept of a control system in engineering
- To develop the ability to identify components of an engineering control system
- To develop the ability to analyse the behavior of control systems
- To develop skills in designing an optimal controller

Learning Outcomes

On completing this course the student should be able to:

• Represent physical systems as mathematical equations and then manipulate these mathematical models in a control context in order to assess how the system behaves.

- Clearly identify components of physical control systems and the control strategies being implemented
- Determine the behaviour of physical systems in relation to stability, disturbances, steady state errors and sensitivity to component changes.
- Design an optimal controller for a physical system to suit the objectives set out prior to design.
- Use computerized methods to implement control systems. **Course Content**

Introduction to Modelling of automatic control systems (10 Hours)

- Open- and closed-loop systems
- Basic elements of control systems
- Principles and examples of open and closed loop control
- Control strategies
- Mathematical models for open- and closed-control systems
- Effect of disturbances and sensitivity to component changes

System representation by diagrams (6 Hours)

- The block diagram
- Block diagram reduction
- Multiple inputs and outputs reduction
- Transfer functions and Laplace transform techniques

Steady state errors

- System classification
- Steady state error for step, ramp and parabolic inputs
- Steady state errors due to different inputs ***Stability and the time domain***
- System poles, zeros and stability
- Routh Hurwitz techniques
- Relative stability
- Root locus technique

Stability and the frequency response domain (8 hours)

- Bode plots or logarithmic plots
- Experimental frequency response
- Nyquist criterion

Approaches to control system design: PID control (8 hours)

- Proportional control
- Integral control
- Derivative control
- Phase compensation
- Implementation of control laws
- Computer implementation of control systems

Digital Control (6 hours)

(6 Hours)

(16 Hours)

- Digital control laws

- Digital to analogue converters
- The z-transform
- Computer controlled sampled data
- Stability

Recommended and Reference Books

[1] W. Bolton, 1998. Control Engineering. 2nd ed. Addison Wesley Longman Limited. ISBN 978-0-582-32773-3.

[2] Arthur G.O. Mutambara, 1999. Design and Analysis of Control Systems. CRC Press LLC. ISBN 0-8493-1898-X.

[3] R.J. Richards, 1993. Solving Problems in Control. Longman Group UK Ltd. ISBN 0582 03298 9.

[4] Francis H. Raven, 1995. Automatic Control Engineering, 5th ed. McGraw-Hill, Inc. ISBN 0-07-051341-4.

[5] S. Thompson, 1989. Control Systems Engineering & Design. Longman Scientific & Technical. ISBN 0-582-99468-3.

[6] Richard C. Dorf, 1980. Modern Control Systems. 3rd ed. Addison-Wesley Publishing Company, Inc. ISBN 0-201-03147-7.

[7] Ronald P. Hunter, 1987. Automated Process Control Systems: Concepts and Hardware. 2nd ed. Prentice-Hall International, Inc. ISBN 0-13-054180-X.

[8] Benjamin C. Kuo, 1995. Automatic Control Systems. 7th ed. Prentice-Hall International, Inc. ISBN 0-13-312174-7.

.[9] W. Bolton, 1991. Industrial Control & Instrumentation. Longman Scientific & Technical. ISBN 0-582-06802-9.