DE 2.3 - Engineering Analysis – DE2 – Electronic Systems for Design Engineers

Course Planning Document (version 2.0)

AIM

This course is a follow on from Year 1's Electronics 1 module by providing a system perspective to electronic systems. The focus of this year module will be on signal interpretation, processing and manipulation; system characterization and modeling; feedback control and tuning of feedback systems. By the end of this module, together with what have been covered in the first year, students will have most of the fundamental concepts of electrical and electronic engineering necessary for a design engineer. Some may even have the prerequisites to study more advanced modules in EEE in their 3rd and 4th years.

THE NEW APPROACH

The planning of this module took a new approach. The capstone project was first created. Then Laboratory sessions required for students to acquire the necessary knowledge and skills to conduct the project was designed. Finally, the lectures and tutorial problems were designed to support the Laboratory sessions.

LEARNING OUTCOMES

On successful completion of the module, students should be able to:

- analyse and interpret signals in both time and frequency domains;
- analyse and interpret signals in both analogue and digital forms;
- use Matlab or similar tools to perform analysis of signals and systems;
- extract useful information from signals through analysis, filtering and other form of signal conditioning;
- understand system behaviour in terms of poles and zeros and perform analysis and prediction of such systems;
- employ principles of feedback to improve various performance parameters in an electronic system;
- analysis simple feedback systems to establish stability in the system;
- design and tune a proportional-integral-differential (PID) controller;
- implement both signal processing and control algorithms in a standalone, embedded electronic system using real-time programming techniques in Python.

TEACHING STAFF

Module Leader: Professor Peter Y. K. Cheung
Teaching Assistants: Dr James Davis, Mr Erwei Wang

COURSE WORKLOAD (120 HOURS, 6 ECTS)

This module will take place in the Spring term in 2017 over a 10-week period consisting of:

- 20 hours lectures (two or three hours lectures in a week, front-loaded)
- 10 hours of tutorial/problem classes (1-hour sessions per week, week 2 to 11)
- 30 hours scheduled laboratory (3-hour session per week, week 2 to 11)
- 60 hours self-study and project work

ASSESSMENT

- 40% coursework: Laboratory experiments (20%) and team project (20%)
- 60% 1.5-hour written examination paper (week 1 of Summer Term)

SCHEDULE (SPRING TERM)

Week	Monday Lecture	Wednesday Lab	Thursday Lecture	Comments
1 (8 Jan)	1	-	-	Exam week
2 (15 Jan)	2,3	Lab 1 – Sig Prc	4 + tutorial	
3 (22 Jan)	5, 6	Lab 2 - Systems	7 + tutorial	
4 (29 Jan)	8,9	Lab 3 – IMU & OLED	10 + tutorial	
5 (5 Feb)	11, 12	Lab 4 – PID control	13 + tutorial	
6 (12 Feb)	-	Oral	-	DRAW week
7 (19 Feb)	14	Lab 5 – PID control	15 + tutorial	
8 (26 Feb)	Peter Away in USA	Proj session 1	16 + tutorial	
9 (5 Mar)	17	Proj session 2	18 + tutorial	
10 (12 Mar)	19	Proj session 3	20 + tutorial	
11 (19 Mar)	tutorial	Project Demo	tutorial	Demo week

TUTORIAL PROBLEM SHEETS AND CLASSES

There will be 6 tutorial problem sheets to support this module.

LABORATORY EXPERIMENTS

These will take place in Weeks 2 to 6 in the Electronics Lab in EEE (Room 114). Each laboratory session is self-contained in a 3-hour session as follow:

Lab 1 – Real-time Signal Processing

Students will learn how to analysis the spectrum of generated sinewave, square wave and triangular wave using Matlab; how to analyse real-time spectrum using Pybench board and its microphone/amplifier/ADC circuits; understand the impact of sampling signal at too low a frequency and the aliasing effect; the impact of rectangular window on the spectrum of signals and how to mitigate this using Hamming window.

Lab 2 – System characterization and modelling

Students will learn how to use the Pybench board to find the dc gain characteristic, the frequency response and the step response of a highly oscillatory 2nd order system; relating the theoretical behaviour of such a system to an actual electronic circuit; the impact of the non-linear effect of the system on the step response; understand how the transfer function of the system and its relationship to the natural frequency and the damping factor.

Lab 3 – IMU and OLED

Students will learn how to use an inertia motion unit (IMU) to provide a good estimate of the pitch angle and rate of change of pitch angle; to use the OLED display unit; to use the driver packages written for the IMU and the OLED display.

Lab 4 – Motor, Interrupts and Digital Filter

Students will learn how to control the two dc motors, use interrupts to estimate the motor speed and use an N-tap moving average filter to low pass filter real-time signals.

Lab 5 – PID control of see-saw (not assessed)

Students will learn how to control the two dc drone motors to control the pitch angle of a see-saw using a PID control.

The assessment of the experiments will be in the form of a 15-minutes individual oral examination on Labs 1 to 4 (not Lab 5), with one of the three members of staff/GTA helping in the laboratory during DRAW week.

TEAM PROJECT

The team project is to design a self-balancing miniature Segway that dance in synchrony to live music. This project encapsulates all the three main topics of this module: signal processing, system characterization and feedback control. A separate document describes the Team Project in details.