Imperial College London

Design Engineering Year 1

DE1.3 - Electronics 1

TOPIC 1 – Introducing the Module

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Welcome to this first course you will take on electronic engineering. This is my fifth time teaching this module. I had a great experience teaching this class for the past few years, and it was planned that I should pass this onto Dr David Boyle. However, due to Covid-19 and remote teaching, I am continuing to lead this module for this year.

This course presents a personal challenge even before the current crisis: how to select and teach from a vast amount of materials we normally teach to first year EE students, and cover all that with you in a quarter of the available time? Even more challenging is: how to ensure that you retain what you learn in electronics for years to come, while you only encounter this topic rarely during the entire degree programme?

All my teaching materials including lecture slides with notes, laboratory work and tutorial problem sheets, can be found on the course webpage shown here. Furthermore, all lectures will be recorded with Panopto.

Course Overview

- By the end of the course, you should have learned and understood:
  - Electrical signals in terms of **voltages** and **currents**
  - Measurements of electrical **signals** and their **accuracies**
  - Basic electrical circuit components: **resistors**, **capacitors** and **inductors**
  - Prediction of voltages and currents in electrical **circuits**
  - Electrical **energy** and **power**
  - **Amplification** of electrical signals
  - **Analogue** vs **digital** signals
  - Basic digital electronic building blocks including **logic gates** and **microprocessors**
  - Behaviour of circuits in **steady-state** or in **transient**
  - How to **sense** the environment and produce electrical signals
  - How to **drive** stuff externally from electronics
  - How to generate or store **energy**
  - How to add **flexibility** and **intelligence** to electronic circuits
  - How to communicate

Being an electronic engineering professor, my opinion is biased. However, I would argue that electronics is now ubiquitous in the modern world. There are now more electronic parts in a car than mechanical ones.

Shown here is a partial list of what you can expect to learn from this course. Even more importantly, before I started prepare for the contents of this course, I wrote a document stating the principle on which I will design this course. In it, I stated five basic principles:

1. **Less is more** – taking material out will result in students learning more.
2. **Concept with rigour** – focus on conceptual understanding instead of details, but at the same time not loosing rigour. Focus on fundamentals.
3. **Top-down, not bottom-up** – where possible go from system level view to component view where possible.
4. **Confidence not ignorance** – bring about student's confidence on electronics. Know what you know, but even more important, know what you don't know!
5. **Formal teaching vs problem based learning** – blending together practical laboratory and project work with the course materials taught formally in lectures.

A copy of this document is put on the course webpage.

Organization and Schedule

- All lectures will be delivered remotely via MS Teams and/or pre-recorded videos. These are are supported by:
  - Four lab experiments and open-ended challenges which will be assessed through an oral assessment session in the final week of term
  - Six problem sheets to help apply what you have learned to answer questions
  - Five quizzes to test yourself on your understanding
- Recommended textbook
  - Practical Electronics for Inventors, Paul Scherz & Simon Monk (~£29 from Amazon, well worth the money!)
- Examination on a date to be confirmed (week starting 22 June)
- Examination paper 60% of module
- Oral Assessment of Labs 30% of module
- Quizzes 10% of module based as participation (done it = full marks)
- An additional maximum of 5% bonus marks for outstanding participation on MS Teams Forum!!

Remote teaching is new to everyone. However, I have a plan as shown here. I will adapt this plan as we progress throughout the term.

Week Starting	Topic	Home Lab	Home work
27 April	1 – Introducing the module	None	Read this document
4 May	2 – Current, voltage, power & Ohm's Law 3 – Resistors and resistor circuits 4 – How to measure V and I? 5 – Nodal analysis & Kirchhoff 's Laws	Lab 0: Watch video on multimeter & oscilloscope	Problem Sheet 1
11 May	6 – Introducing the Home Lab Kit 7 – Signals: DC, AC, analogue, digital, PWM, exponential rise & fall 8 – Linearity & principle of superposition 9 – Thevenin's equivalent circuits	Lab 1: Measurements using the multimeter & Scope	Problem Sheet 2 & Quiz 1
18 May	10 – Lab 1 explained 11 – Capacitors and RC circuits 12 – Frequency response & transient behaviour in circuits 13 – Diodes & transistors, idea of amplification	Lab 2: Circuits based on resistors & capacitors	Problem Sheet 3 & Quiz 2
25 May	14 – Lab 2 explained 15 – Operational Amplifier circuits 16 – Number systems, digital signals & logic gates 17 – Simplified view of a computer system	Lab 3: Operational Amplifiers	Problem Sheet 4 & Quiz 3
1 June	18 – Lab 3 explained 19 – ESP32 & Micropython 20 – Inductors, transformer and electromagnets 21 – Drive: PWM, H-bridge, Servo motors, Neopixels	Lab 4: Programming ESP32 using Micropython	Problem Sheet 5 & Quiz 4
8 June	22 – Lab 4 explained 23 – Sense: transducers and sensors 24 – Link: UART, I2C, SPI, Bluetooth, Wifi 25 – Source: batteries, solar panel, dynamo	Lab 5: Challenges with Stretched Goals – part 1	Problem Sheet 6 & Quiz 5
15 June	26 – Revision lecture 1 27 – Revision lecture 2	Lab 6: Challenges with Stretched Goals – part 2	
22 June	Written Examination (date TBD)	Practical Remote Assessment (date TBD)	

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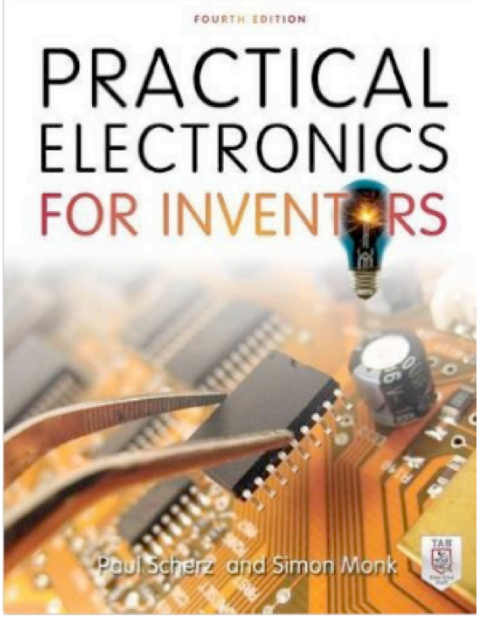
Buy this book!

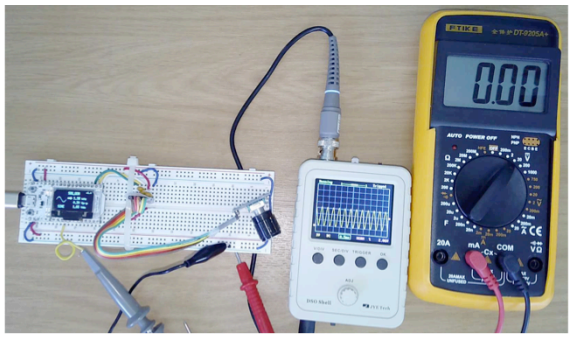


- Useful for finding out what you don't understand from my lectures
- Useful reference for the rest of your degree and beyond
- Over 1000 pages for under £30 – a bargain!

I will be providing notes throughout this course. So strictly speaking, you could get away without using any textbooks. However, I recommend only one textbook – Practical electronics for inventors. This book is particularly suitable for Design Engineers because it has a good balance between theory and practice, it is relatively low cost in spite of size (>1000 pages) and it covers everything you need in electronics at sufficient depth.

Home Laboratory Kit

- Home Lab Kit containing everything you need to conduct the practical part of this module from home (with a few exceptions – see later)
- Kit contains:
  - Measurement equipment on loan to you
  - Prototyping breadboard with a ESP32 microcontroller as a signal generator
  - Other electronics components to support the Lab Experiments
- Sustainability – return the measurement equipment in the Autumn, and anything else that can be re-use



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This module will be based on talks and practical laboratory experiments. This is achieved through a Home Lab Kit that I have prepared for you. These will be sent to you via courier in next week. Depending on where you live, I expect that you will receive your Kit by the end of next week or the following week.

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What you need to do immediately?

- Go to this webpage and complete your address for the Kit to be sent IMMEDIATELY (need to organise the courier)
- Here is the link:

https://forms.office.com/Pages/ResponsePage.aspx?id=B3WJK4zudUWDC0-CZ8PTB6WYWOWN095Fg5Cucl_BTrBURTdSNFJSRUJVSUxJWk1UOTFJNERIMlFQNi4u

- You will also need to provide:
  - One (but better two) 9V battery for multimeter and your circuit
  - Wire cutters (small)

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Please make sure that you complete your address survey asap, and not later than noon on 2 May 2020.

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