IMPERIAL

Department of Materials

FACULTY OF ENGINEERING

Year 2 Handbook

Sample

Introduction

This handbook contains specific information for the Year 2 students in the 202x-2x cohort, including the module details and assessment deadlines and year composition for this academic year. It is to be used in conjunction with the General Handbook for all students for full regulations and guidance on the undergraduate programmes in the Department of Materials.

This information is accurate at date of publication, with reference to central registry systems, however it may be updated due to unforeseen circumstances.

1. Programme Information

Key Dates 202x-2x

You are required to be present from the start to the end of all term dates, do not plan travel during term time – if you do it will normally *not* be considered as mitigation. Please refer to the link below for a specific listing of term dates:

Term dates | Administration and support services | Imperial College London

Closure dates

Please refer to the link below for College closure dates:

College closures | Administration and support services | Imperial College London

Attendance at lectures, workshops, tutorials, labs, briefing sessions, and problem classes is considered **mandatory** during all term time. Attendance can be taken at any time; it will be taken in all laboratory tutorials. Absence will only be accepted with mitigation.

Year structure

Please refer to the programme specification for a breakdown of weighting and credit weighting:

Programme specifications | Staff | Imperial College London

Module	Name	% Contribution
MATE50001	Maths Test 1 - December	40%
	Maths Test 2 - June	30%
	Programming Challenge	30%
MATE50002	Degradation and Corrosion Test - December	30%
	Devices Test (Part 1) - June	25%
	Batteries Test (Part 2) - June	25%
	Batteries Exercise- June	20%
MATE50003	Preliminary Submission	20%
	Interim Submission	40%
	Final Submission	40%
	Engineering Skills	Pass/Fail
MATE50004	Progress Assessment	20%
	Examination - March	80%
MATE50005	Characterisation Test 1	20%
	Characterisation Test 2	20%
	Characterisation Data Exercises (5% each) – Autumn	25%
	Characterisation Exercise Report – Spring	35%
MATE50006	Progress Assessment	20%
	Examination – May	80%

***The information above is correct at the time of publication, however changes may be made during term time and will be communicated to the cohort via email if necessary**

2. Coursework Deadlines

Please note that these dates are **preliminary and may change throughout the year**. All times are given in the London time zone. You will be notified of changes by the Student Office by email.

Term	Module	Assignment / Event	Due Date	Format	Feedback/ Marks
Autumn	MATE50005	Characterisation Instrument Labs (5 labs) Unknown Sample Exercise	End of lab session	Electronically via Blackboard Learn Individual/group submission as specified	2 weeks *
Spring	MATE50001	Programming Challenge	09:00 09/01	Electronically via Blackboard Learn	3 weeks *
	MATE50005	Characterisation Exercise Report (Draft)	09:00 **Group A&B:** 27/01 **Group C&D:** 29/01	Electronically via Blackboard Learn	2 weeks*
	MATE50005	Peer Feedback Exercise	09:00 06/02	Electronically via Blackboard Learn	N/A
	MATE50006	Progress Assessment	09:00 13/02	Möbius Assessment	Immediate
	MATE50004	Progress Assessment	09:00 20/02	Möbius Assessment	Immediate
	MATE50005	Characterisation Exercise Report (Final)	9:00 25/02	Electronically via Blackboard Learn	End of term
	MATE50003	Preliminary Submission	9:00 17/03	Electronically via Blackboard Learn	2 weeks*
Summer	MATE50003	Interim Submission	9:00 19/05	Electronically via Blackboard Learn	2 weeks*
	MATE50003	Small Group peer assessment	09:00 22/05	My Department	2 weeks*
	MATE50003	Final Report Draft	09:00 29/05	Electronically via Blackboard Learn	2 weeks*
	MATE50002	Batteries poster exercise	Details in lab	Oral (presentation) and Electronically via Blackboard Learn (poster submission)	2 weeks *

	MATE50003	Final Submission	9:00 16/06	Electronically via Blackboard Learn	2 weeks *
	MATE50003	Large Group peer assessment	09:00 19/06	My Department	2 weeks*

* The above dates do not include the Student Office processing time which can be up to **additional 5 working days** on top of the estimated feedback/mark timeframe. Please note, if the **marking is submitted late by the marker**, then the Student Office will get out marks as soon as possible.

Provisional Assessment & Examination Timetable

All dates and times are provisional and may change. For confirmed times/dates please refer **only** to your Celcat timetabled exam events, not the Handbook for accuracy. No travel should be booked based on these times nor should other commitments be agreed to. Mitigation due to assumed dates from this timetable will not be accepted for problems attending examinations that are moved for any reason.

Autumn Term

12/11/202x AM MATE50005 Characterisation Test 1
06/12/202x AM MATE50005 Characterisation Test 2
09/12/202x AM MATE50001: Maths Test - Autumn Test (Written)
10/12/202x AM MATE50002: Performance - Corrosion and Degradation Test (Written)

Spring Term

20/03/202x AM MATE50004: Structure – Exam (Written)

Summer Term

29/04/202x AM MATE50006: Properties – Exam (Written)
05/06/202x AM MATE50002: Performance - Batteries and Devices Test (Written)
10/06/202x AM MATE50001: Maths - Summer Test (Written)

3. Module Information

MATE50001 Mathematics and Computing II

Why study this module?

This course is a continuation of the first-year course MATE40001 and aims to give students a firm foundation in the aspects of Mathematics and Computing of most relevance to Materials Science and Engineering, especially the topics required in subsequent years of study.

At the end of this module students will be able to:

- employ vectors calculus to solve problems in MSE.
- relate Fourier series and Fourier transforms and apply to diffraction and systems described by partial differential equations.
- operate tensor algebra in problems related to elasticity, anisotropic dielectrics and conductivity.
- construct partial differential equations to solve a problem in MSE.
- apply vector algebra and partial differential equations to address problems in electromagnetism.
- discuss experiments in which the outcome is uncertain.
- create python code to implement numerical methods and solve problems in MSE.

How will I be Taught?

Mathematics
48 lectures: Autumn and Summer terms
8 workshops: Autumn and Summer terms
Computer Programming
24 hrs of programming sessions: Autumn term
New mathematical concepts will be introduced to you in lectures. You will have an opportunity to test your understanding of the material through problem solving, non-assessed problems will be reviewed in small group tutorials. Computing will be taught to you through a series of interactive teaching sessions in which a coding concept will be introduced and then used by you in a program that solves a set problem.

Reading List:

- Mathematical Methods for Physicists and Engineers, K. F. Riley, M. P. Hobson and S. J. Bence, CUP 2006
- Engineering Mathematics Through Applications, K. Singh, Palgrave Macmillan 2003
- Mathematical Methods in the Physical Sciences, M. Boas, Wiley 2006
- Mathematical Methods for Physicists, G. Arfken and H. Weber, Academic Press 1995
- Practical Physics, G. Squires, CUP 2001
- Think Python 1st Edition, by Allen B. Downey

How will I be assessed?

The mathematical aspects of the module will be assessed in termly tests. Your computing skills will be tested through a group programming challenge as well as an in-class assessment.

MATE50002 Performance of Functional Materials

Why study this module?

In this module you will first consider the performance of materials in the environment and how this may influence their use, looking at the degradation of glasses and polymers and the corrosion of metals. Functional materials underpin the electronics industry and the design criteria for semiconductors in devices will be described. Finally, the performance of battery materials will be discussed, combining concepts in materials processing, structure and properties from across the first two years.

At the end of this module you will be able to:

- Appraise materials for use in different environments.
- Calculate the rate of loss of a material under a given set of conditions.
- Illustrate the key components in simple electronic devices.
- Describe the strengths and weaknesses of different battery designs.
- Compute the theoretical performance of a battery given thermodynamic and kinetic parameters.

How will I be Taught?

34 lectures: Throughout the year
7 workshops: Throughout the year
4 hrs of Lab sessions: Summer term
New concepts will be introduced to you in lectures. You will have an opportunity to test your understanding of the material through problem solving, non-assessed problems will be reviewed in lectures and at workshops. A group poster project will give you the opportunity to review battery materials with respect to the processing, structure and property principles taught across years 1 and 2.

Reading List:

- S. Sze and M.-K. Lee, Semiconductor Devices. Physics and Technology, John Wiley and Sons
- C. Kittel, Introduction to Solid State Physics, 8th ed. Wiley, 2005.
- D.A. Jones, Principles and Prevention of Corrosion, Macmillan 1991
- RJ Young and PA Lovell, Introduction to Polymer Science, Chapman And Hall 1991
- Robert A. Huggins, Advanced batteries- Material Science Aspects https://link.springer.com/book/10.1007/978-0-387-76424-5

How will I be assessed?

The modules will be assessed by three in-class tests on Materials Degradation, Semiconductor Devices and Battery Materials plus a group poster presentation exercise on batteries.

How will I receive feedback?

You will receive written feedback and indicative marks on the tests and practical work within two weeks of submission. Feedback on tests is provided as a written commentary on where the cohort performed well and poorly.

MATE50003 Engineering Practice II

Why study this module?
You will gain the experience of working in a team- reflecting on how Engineers in industry often operate. The project work will allow you to develop the characterisation knowledge learned in the year 2 Characterisation Module (MATE50005), develop confidence in using departmental characterisation facilities, generate and analyse your own data and consider the importance of materials design and selection.
In your groups you will identify the key components of an object that you are provided with, determine the function of each component and how this contributes to the overall operation and, using your characterisation skills and knowledge as a Materials Scientist, determine exactly what materials each of the components are made from and rationalise choices made by the manufacturer. Using this knowledge, your group will be able to elucidate the processing routes used for the manufacture of each component and of the completed object and then consider how, using your knowledge, you would improve the object. What is improved is up to your team to decide, it may be as simple as how to use lower cost materials or how to use better materials that may result in greater efficiency or an increased lifetime – how about improving the primary functionality or adding more functionality. The choices are up to you to consider and investigate.

At the end of this module you will be able to:
- Produce engineering drawings of the object you are given and the new object you define.
- Determine the materials used in the key components of your object.
- Understand more about materials selection to critique the materials you have identified.
- Describe the manufacturing methods employed in the production of your object.
- Plan, within budget, a series of analytical experiments.
- Propose alternative materials for your object that you consider would improve it.
- Operate effectively as a team.

Skills you will develop during this module:
- Characterisation skills and data interpretation.
- Project management.
- Communication skills (technical briefings, meetings, presentations).
- Technical drawing.

How will I be Taught?
1hr introduction lecture: Spring term
6-8 hrs guest lectures: Summer term
40 hrs of practical/labs: Summer term
The cohort will be divided into groups such that each group will have no more than 8 members. Each group will be provided with a household object that will have to be drawn, disassembled and the key components identified. Using the facilities within teaching labs and the suite of characterisation equipment you have been introduced to previously you will determine which materials have been used in the key components and identify how the overall object functions. Each group will have a virtual budget that will be used to access the resources and facilities required. Each group will have an assigned academic mentor with whom you will meet regularly during the course of the project.

Reading List:
- Introduction to Engineering Design (Samuel and Weir)
- Materials selection in mechanical design (Ashby)

How will I be assessed?

There will be near continual assessment for the duration of the practical work. A total of 5 pieces of work will be submitted during the project in addition to an oral presentation. In addition, there will be an element of peer-assessment within each of the groups that contribute to the overall mark.

The 5 pieces will cover:

1. Technical drawing and primary component identification.
2. Plan for characterisation (rationale, timing, costs)
3. Summary of characterisation data and data analysis.
4. Identification of manufacturing methods used.
5. Suggestions for improvement.

How will I receive feedback?

Formative feedback will be provided on all 5 pieces of work by your academic mentor. The feedback will allow you to refine your knowledge and ensure that by the time pf your presentation that you are confident with your data and your understanding of the design and manufacture of your object. Evaluation of the presentation will be provided by means of a group grade and by written comments made by the academic panel observing the presentations

MATE50004 Structure II

Why study this module?

In this module you will evaluate how a material's structure determines its properties/performance and learn how the structure of a material can be controlled at the microscale through appropriate processing.

At the end of this course students will be able to:

- Construct and analyse ternary phase diagrams.
- Describe the formation and role of precipitates in materials science and engineering.
- Illustrate the role of surfaces and interfaces in material processing and properties.
- Describe and predict the properties of polymers
- Describe and predict the properties of composite materials.

How will I be Taught?

56 lectures: Spring term

10 workshops: Spring term

New concepts will be introduced to you in lectures. You will have an opportunity to test your understanding of the material through problem solving, non-assessed problems will be reviewed in lectures and at workshops.

Reading List:

- Solid Surfaces, Interfaces and Thin Films, Hans Lüth
- D.A. Porter and K.E. Easterling, Phase Transformations in Metals and Alloys, Second Edition, Chapman and Hall, 1992
- An introduction to composite materials, Hull & Clyne, Cambridge University Press, Cambridge, 1996
- Introduction to Polymer Science, RJ Young and PA Lovell, Chapman And Hall 1991

How will I be assessed?
The modules will be assessed by: in class exercises, written reports on the practical exercises and an end of module examination.

How will I receive feedback?
Feedback on examinations is provided through written commentaries on each question that state where the cohort did well and highlight common mistakes.

MATE50005 Materials Characterisation

Why study this module?
The ability to characterise materials and to assess the structure, morphology, composition, and functional/mechanical properties of materials is underpinning all fields of Materials Science and Engineering. By studying this module, you will enhance your skills in the application of advanced characterisation techniques for the study of structure-property relationships in materials. This module is designed to give you the firm foundation in the fundamentals of the Materials Characterisation techniques that you may employ in the Engineering Practice II, Processing Laboratory and Individual Research Project modules.

How will I be Taught?
38 lectures: Autumn term
5 Lab sessions/Workshops: Autumn term
An open-ended characterisation exercise will take place in the Spring term, leading to a report due at the end of the Spring term.

The fundamental principle of Materials Characterisation will be discussed in lectures and you will have an opportunity to test your understanding in workshops. Your skills in using characterisation instruments will be developed through a series of laboratory sessions, part of the practical course will involve you using a series of different techniques to determine the composition, morphology, structure and properties of an unknown material.

Reading List:
- Characterization of Materials, E.N. Kaufmann, 2nd edition, Wiley (2012).
- Materials characterization : introduction to microscopic and spectroscopic methods, Y. Leng, 2nd edition, Wiley (2013).
- Microstructural Characterisation of Materials, D. Brandon & W. D. Kaplan, 2nd edition, Wiley (2008).
- A Journey into Reciprocal Space, A.M. Glazer, Morgan & Claypool (2017).
- Introduction to magnetic materials, B.D. Cullity, C.D. Graham, 2nd edition, IEEE/Wiley (2015). (Supplementary)
- An Introduction to Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS) and its Application to Materials Science, S. Fearn, Morgan & Claypool (2015). (Supplementary, available online)
- Surface Analysis: the principal techniques, J.C. Vickerman and I. Gilmore, Wiley (2009).

- Electron Paramagnetic Resonance Spectroscopy Fundamentals. P. Bertrand, 1st edition (2020). (Supplementary)
- Fundamentals of Crystallography, C. Giacovazzo, 3.rd edition, Oxford University Press (2011) (Supplementary)
- Principles of Instrumental Analysis, D.A. Skoog, 6th edition, Brooks/Cole (2007). (Supplementary)
- Organic Spectroscopy, W. Kemp 3rd edition, Red Globe Press (1991).
- Characterisation Methods in inorganic Chemistry, M.T. Weller and N. A Young, Oxford University Press (2017).

How will I be assessed?
The module will be assessed by two in-class tests that will test both your understanding of the fundamental principles underpinning the different techniques and your ability to interpret experimental data. You will also submit written reports on the laboratory exercises.

How will I receive feedback?
You will receive indicative marks on the tests and practical work within two weeks of submission. Formative feedback on the tests will be provided as a written commentary on where the cohort performed well and poorly.

MATE50006 Properties II

Why study this module?
In this module you will learn how to understand the mechanical and physical properties of materials with emphasise on mechanisms by which a structural material may fail, and states of stress from the crystal scale to components. You will also revisit the electronic and magnetic properties of materials, introducing quantum mechanical concepts, to form a deeper understanding of magnetism and charge transport.

At the end of this course students will be able to:
- Calculate, Understand and manipulate stress and strain tensors in materials and components.
- Analyse the micro mechanisms of fatigue and fracture in ductile and brittle materials.
- Employ the free and the nearly free Electron model to describe the electronic properties of a material.
- Appraise material magnetism using classical and quantum models.
- Explain the response of different materials to an AC electric field.

How will I be Taught?
48 lectures: Spring term
12 workshops: Spring term

New concepts will be introduced to you in lectures. You will have an opportunity to test your understanding of the material through problem solving, non-assessed problems will be reviewed in lectures and at workshops.

Reading List:

- JF Nye, Physical Properties of Crystals, OUP, 1957
- GE Dieter, Mechanical Metallurgy, McGraw-Hill, 1988
- TL Anderson, Fracture Mechanics, Fundamentals and Applications. Taylor and Francis, 2005.
- C. Kittel, Introduction to Solid State Physics, 8th ed. Wiley, 2005.
- J. Singleton, Band Theory and Electronic Properties of Solids, 1st ed. OUP Oxford, 2001.

How will I be assessed?

The modules will be assessed by: in class exercises, written reports on the practical exercises and an end of module examination.

How will I receive feedback?

Feedback on examinations is provided through written commentaries on each question that state where the cohort did well and highlight common mistakes.