Department of Materials
Year 2 Handbook

2016 — 2017
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The Course

You will start work on your second year course in the second week of the autumn term, you are expected to attend and participate in all lectures, tutorials and laboratory classes.

Workshops
There will be sessions once or twice a week, lasting for about an hour in which you will be tutored in each subject. The groups are the same as last year and you will receive tutorials spread across the Autumn and Spring terms. These sessions are extremely useful as you will find that discussing and reviewing topics in a small group gives you a much deeper understanding of the course. You will be given tutorial question sheets and these should be completed prior to your next subject tutorial so that they can be discussed and reviewed. Don't waste your chances by failing to attend these sessions, and if for some reason you cannot be there, please do make sure you inform your tutor.

Personal Tutoring
Do make sure you keep in touch with your personal tutor, he or she can be a great help to you. As you know, if you have problems or worries and your personal tutor cannot help, you can always contact the Senior Tutor (Prof Julian Jones).

Laboratory Classes
Labs are held four afternoons a week in the Autumn term and two in the Spring term. The Autumn term labs have the same format as in the 1st year, but the Spring term labs are quite different. For the first half of the Spring term you will be carrying out an extended lab (plus one session doing an x-ray lab). After the labs you will be required to submit an electronic lab report (PDF format) online using Blackboard (submission is always within 7 days of the date of the lab), which will be marked and will contribute towards your degree. You will get the marks and feedback directly from Blackboard as well. The format will vary according to the demands of each lab.
Course Content

In the second year you will study eight courses as follows:

MSE 201 Mathematics and Computing
MSE 202 Materials Chemistry & Polymer Science
MSE 203 Mechanical Behaviour
MSE 204 Microstructure
MSE 205 Electronic Properties of Materials
MSE 206 Materials Engineering
MSE 209 Personal Development
BS 0841 Project management

All courses are taught over both the Autumn and Spring terms and are supported by tutorials, and assessed by a three hour examination in the Summer term.

Full descriptions of all modules are available on Blackboard and via the Departmental Student System (DSS—this is where you can select your module options in Year 3 and Year 4).

MSE 201 Mathematics and Computing
Dr Paul Tangney, Dr Andrew Horsfield, Dr Arash Mostofi, Dr Mark Oxborrow and Dr Johannes Lischner

The course is delivered by way of lectures and classwork sessions. The objective of the course is to introduce you to a range of numerical and statistical techniques which can be successfully employed within the broader framework of the course. There will also be a short series of lectures covering advanced pure mathematics. There will be assessed pieces of coursework to be completed.

MSE 202 Materials Chemistry and Polymer Science
Prof Julian Jones, Prof Natalie Stingelin and Dr Jiahui Qi

This series of lectures will develop concepts introduced in the first year courses in MSE 102 and 104. The materials chemistry part of the course will extend you knowledge of solution thermodynamics, interfacial behaviour and corrosion. The polymer science part of the course focuses on the structure and deformation behaviour of polymeric materials.

MSE 203 Mechanical Behaviour
Dr Finn Giuliani, Prof David Dye, Prof Trevor Lindley and Dr Minh-Son Pham

This series of lectures will develop concepts introduced in the first year courses in MSE 103 and 104. The first part of the course focuses on the micro-mechanisms involved in deformation, fracture, fatigue and creep. The second part of the course concentrates on developing the tools required to determine quantitatively the conditions for failure by these mechanisms in real components. There are three Mechanical Behaviour labs and 2 progress tests.

MSE 204 Microstructure
Dr Chris Gourlay—TBC

This series of lectures will develop concepts introduced in the first year course in MSE 104. The first part of the course focuses on solidification paying particular attention to three component systems and ternary phase diagrams. The second part of the course concentrates on the phase transformations that take place in the solid state.

MSE 205 Electronic Properties of Materials
Prof Norbert Klein, Dr Stephen Hanham and Dr Michelle Moram

This series of lectures will develop concepts introduced in the first year course in MSE 105. Knowledge of electronic structure and properties will be developed and used to explain dielectric and magnetic behaviour. There will also be lectures covering the materials used for electronic devices and their selection. There are two Electronic Properties labs.
MSE 206 Materials Engineering

MSE 206 Process Principles
Dr Peter Petrov and Dr Khalil Rhazaoui
This lecture course introduces the concepts of fluid, heat and mass transfer as applied to the processing and in-service behaviour of materials. The course will be assessed by one test, two pieces of coursework and a poster.

MSE 206 Materials Characterisation
Dr Cecilia Mattevi
This course is designed to give students an introduction to common materials characterisation techniques, especially as a foundation for the laboratory work and case study later in the year. The course will cover the design and operation of the equipment, the information that can be gained from the different techniques, and the sample requirements and will be assessed by a test.

MSE 206 Case Study
Prof Trevor Lindley and Dr Martyn McLachlan
The lecture course is aimed at developing an engineering approach to selection of materials for particular applications, and to introduce the available methods for processing and characterising materials and fabricating components.

The case study is conducted in groups of between 4 and 6 students, under the supervision of a member of academic staff. You will be assigned an article (i.e. a kettle, toaster, golf club, etc.) and you will be expected to dismantle it, assess the design and function of the individual components, and then conduct tests to identify the material and production method used. Using the knowledge gained from the lecture course you will be expected to suggest alternative materials and production methods. The project is assessed by a group report and oral presentation. The case study is an extremely important part of the coursework for the 2nd year. It contributes approximately 30% to the total coursework mark for the year. See page 7 for more details regarding the case study.

BS 0821 Project Management
Dr Jiahua Wu
The course provides students with an understanding of project management and its central role in the modern business organisation. It presents methods that are used to:

- Define project environments, such as organisational strategy and major stakeholders,
- Design project management processes via time planning, cost and benefits planning, as well as risk management,
- Execute projects, by considering elements of organisational theory, management and leadership, as well as project control, and
- Improve project performance via organisational learning.

The course challenges some of the assumptions underlying traditional project management, such as the focus on time, cost and quality (the ‘triple constraints’) and the ‘one size fits all’ approach. While traditional project management tools and techniques are essential, students will be introduced to new concepts, frameworks and models which show that projects are increasingly important to the growth and innovation objectives of the modern organisation.
MSE 209 Personal Development

Personal Tutors
As well as the academic subjects listed above, you will receive general instruction in a number of more general skills. During the next year you will be starting to consider what career you will wish to follow and if you are on the 4 year courses will have to start thinking about applying for your placement. To help with this we have a series of career exercises that run in the summer term of the 2nd year. There will be workshops on CV preparation, interview skills and psychometric testing.

Extended Lab
At the end of the Autumn term you will select an extended project. These are open ended projects that you carry out over 5 weeks as a group during the Spring term (except the MATLAB project which is done individually). They are much more like research than the labs carried out up to this point, in that the outcome is not completely known. At the end of this you each write your own report (one per student). To help you prepare for the project you will complete a RAFT (Risk Assessment Foundation Training) over the Christmas holiday. The options for the extended labs are expected to be as follows, but will be confirmed during the academic year:

- Theory (MATLAB) Dr Andrew Horsfield
- Biomaterials Dr Iain Dunlop
- Nanomaterials Prof Jason Riley and Dr Cecilia Mattevi
- Ceramics (x 2) Dr Luc Vandeperre
- Metals Dr Chris Gourlay
Case Study: Spring Term

This is one of the major pieces of coursework in the second year. The primary objective is to identify what materials were used in your group’s article, and to provide you with practical experience in the important techniques used for the characterisation of materials. Secondary objectives are to find out what processing route was employed and why the particular materials and manufacturing processes were chosen in each case, and to suggest alternative materials and processing routes using the materials selection principles discussed in the second year lecture course MSE 206.

The Manufactured Article

The chosen articles will contain enough different parts to enable each student to study one component. Each of the selected components will be made from one type of material drawn from the classification scheme given below. Wherever possible three different classes of material from the following list will be covered:

- Ceramics, glasses and glass-ceramics
- Metals and alloys
- Polymers
- Composites

Some articles such as a television set may be made up of many components, and it is desirable to choose a selection which are functionally related to each other. Where moving parts are involved it is essential that both contact surfaces are studied.

Laboratory Investigation

When you receive your manufactured article you should make a sketch or take a photograph of it in its whole state and then dismantle it, keeping a careful record with sketches, notes, photographs, etc. An essential part of the materials selection analysis is the identification of the precise function of each component and it is difficult to do this if you have only a jumbled mass of pieces in a cardboard box! Discuss your choice of components and their suitability with your supervisor and make appropriate sketches and/or photographs of each component. Once you have selected your items you should produce an outline plan for the preliminary work you intend to do and show this to your supervisor.

For most of the materials you encounter, initial characterisation can be obtained from simple laboratory techniques such as hardness determination, density measurements, burn tests, magnetic tests etc. and, when you have undertaken these simple tests and recorded the results, you should show your log book to your supervisor.

You will now be at the stage where you will need to use more sophisticated techniques such as X-ray diffraction, infra-red spectroscopy, optical and SEM characterisation.

<table>
<thead>
<tr>
<th>Person in Charge</th>
<th>Technique</th>
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<tbody>
<tr>
<td>Dr Mahmoud Ardakani - EM Area</td>
<td>1) SEM and EDX</td>
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<td>Mr Richard Sweeney - Room LG61</td>
<td>2) X-Ray diffraction</td>
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<td>Ben Chan</td>
<td>3) Spectroscopy (FTIR/UV-vis)</td>
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<td>Ben Chan</td>
<td>4) Light Photo-Microscopy</td>
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<td>Ben Chan</td>
<td>5) Mechanical testing (tensile testing/compression testing/3-point bend/hardness)</td>
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<tr>
<td>Ben Chan</td>
<td>Other characterisation (density determination/hot plate set up for melting point)</td>
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<tr>
<td>Ben Chan</td>
<td>Sample prep (demolition consultation/epoxy moulding/soldering)</td>
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The person in charge of the facility will keep a record of use and you should perform at least one analysis from each of the techniques 2-5. Use of the equipment is timetabled but each group of students has to organise booking within that time. Before you undertake any of these techniques you must consult the person in charge to ensure that you know how to select, prepare and mount the specimens you have chosen for analysis.

Consult your supervisor for advice on which samples are most appropriate for techniques 2-5. Microstructures should be illustrated by photomicrographs with appropriate micron markers and details of etching.

**DO START EARLY!** If you leave things until the last few weeks, the demand will be too great for the facilities available. In most cases the chemical composition of the material can be estimated from the microstructure and properties. What is required is the general class of material, not an exact chemical composition; for instance, it is sufficient to show that a die casting material is a hypo-eutectic Al-Si alloy and we do not need to know that the Si content is, say, 8%. Similarly, for polymeric materials we need to know if it is a thermo-plastic or thermoset and whether it is filled or not. The exact nature of the polymer or the filler is of secondary importance.

**Report**

Each group is required to submit a single copy of a jointly prepared report, and to submit this to Blackboard. Lab books should be returned to your group’s supervisor. The bulk of the report should include a general description of the manufactured article and its purpose, and a detailed and quantitative account of each of the components studied. You should include as a major topic, the details of all laboratory investigations, and the reason for your choice of each one. This should be followed by a discussion of why the particular materials and processing route were selected for each component.

Usually it will be convenient to start with a general description of the manufactured article as a whole and its purpose, and you can then take each component in turn, describing your observations and interpretations. Your discussion of the selected material should follow the approach described in the lectures, i.e. you should identify the component's function and then deduce the required property characteristics which should be ranked according to their importance. As far as possible we would like these characteristics to be expressed in quantitative terms which may involve simple stress analysis, heat transfer calculations, analysis of electrical properties, etc. You should aim to compare candidate materials in terms of a quantitative decision parameter, usually such parameters will include the cost per unit mass of the materials (refer to the texts listed in the attached bibliography).

When discussing the production process you must make some assessment of the number of components to be produced in a given batch. You must also take into consideration factors such as shape, size, complexity, surface finish, the presence of holes, etc. The group should ensure that the parts prepared jointly, and the individual sections (which must be identified), blend into a coherent whole in the report. *This is one of the purposes of regular meetings of the whole group.*

The word count for the report is 2000, and it should be uploaded to Blackboard by midday on **Friday 12th May 2017**. Further details of which will be given in due course.

Lab books should be handed to the supervisor directly or put in their pigeon holes on the 2nd floor (please do email them to inform them that you have left your group’s lab book in their pigeon hole).
Presentations
You will be required to present some of your results and the assessment will be based on your ability to present technical information and to answer relevant questions concerning techniques. The content of your case study is assessed from the report. Each student will be allowed five minutes for their presentation and there will be an additional five minutes for questions to the whole group. In the time available it is not possible to present all your results so you should aim to give a general introduction to your case study and then concentrate on one or two components, presenting both the experimental observations and the materials selection analysis. You will probably find it convenient to use a Power Point Presentation for your talk. Spend time preparing your talk and try to avoid reading a prepared script, this experience will stand you in good stead for the future. You are required to attend all the presentations and groups will be asked to put questions at the end of each one. Presentations will take place on Tuesday 20th June 2017.

Marks
The marks for the Case Study form a significant proportion of the total second year coursework mark. Case Study report marks will be awarded as follows (a copy of the marking criteria is available on Blackboard):

35% for the report as a joint effort,
25% for the individual section,
20% for effort, initiative, log book, etc. on an individual basis, and
20% for the individual contribution to the presentation, making a total of 100

Safety
Before dismantling your article, each group should discuss the risks involved with their supervisor. Each group must complete a COSHH form (Control Of Substances Hazardous to Health) in consultation with their supervisor before any experimental work involving potentially hazardous chemicals is undertaken. If you have any doubts on safety you should consult the Departmental Safety Officer, Dr Peter Petrov.

Reference Texts
Smithells C., Metals Reference Book. Library ref. 669
Encyclopedia of Materials Science and Engineering, Editor-in-Chief Michael B. Bever 1986, Library ref. R539.2
Concise Encyclopedia of Advanced Ceramic Materials, Editor, R.J. Brook, 1990, Library ref. 666.3/7
Materials in Action series (four volumes), Edited by C. Newey and G. Weaver 1990, Open University
Option Choices and Project Allocation for the Third Year

At the beginning of the summer term you will be given information on the choice of options for study in your third year. You will be asked to confirm your selections as soon as possible so we can plan the timetable accordingly. However, if you do change your mind, providing the course selected is not over subscribed, you may be permitted to change your selection**. Information regarding the options available in Imperial Horizons and Management subjects will also be provided during the summer term with the necessary instructions for registration.

**In order to request a change in your option selection you need to contact the Student Office; any requests must be confirmed before **Friday 16th June 2017**.

The system for deciding which BEng students can do an individual research project are as follows:

In the summer term, interested students will be interviewed by the DUGS. If the DUGS agrees they have a good case for why they should be permitted to conduct a project, the student will need to achieve a minimum of 70% overall in the second year to be considered. On achieving this they will be permitted to select a project from the list provided over the summer and will be allocated a project when these are completed for the MEng students.
Qualification to Proceed to the Third Year

In order to proceed to the third year students must normally pass each exam with a minimum of 40%, and coursework must be passed with an overall average of at least 40%; with an overall aggregate mark of 40% for each unit and the year. In the case of MEng students, individual performances will be critically assessed to determine suitability to continue on the MEng course. An MEng student would normally be expected to achieve a total mark for the year in excess of 60%.
Looking to get the most out of your degree?

The Imperial Horizons programme offers a wide range of courses for all Imperial College undergraduates. It is designed to broaden your education, inspire your creativity and enhance your professional impact. Over 80 different short course options are available from four fields of study throughout your undergraduate degree.

Please see the Imperial Horizons website for further information: [http://www.imperial.ac.uk/horizons/course-options/second-year-undergraduates/](http://www.imperial.ac.uk/horizons/course-options/second-year-undergraduates/)

### Second Years (Mondays: 4-6pm)

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<th>Course</th>
<th>Total number of weeks</th>
<th>Autumn Term</th>
<th>Spring Term</th>
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<tbody>
<tr>
<td></td>
<td>Weeks</td>
<td>Start</td>
<td>End</td>
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</table>

"A very interesting module and structure - completely different to what I'm used to, and exactly what I was looking for in a Horizons course"
Departmental Staff List

Academic Staff

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Prof Neil Alford
Dr Ainara Aguadero
Dr Stefano Angioletti-Uberti
Prof Alan Atkinson
Dr Ben Britton
Dr Iain Dunlop
Prof Fionn Dunne
Prof David Dye
Prof Mike Finnis
Dr Theoni Georgiou
Dr Chris Gourlay
Dr Finn Giuliani
Prof Robin Grimes
Dr Sandrine Heutz
Dr Andrew Horsfield
Prof Julian Jones
Prof Norbert Klein
Prof John Kilner
Prof Trevor Lindley
Dr Johannes Lischner
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Dr Martyn McLachlan
Dr Michelle Moram
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