MS Part II Course Handbook 2016/17

Part II Projects 2016/17 ................................................................. 2
Induction Course Schedule .............................................................. 4
Other Transferable Skills Training & Related Topics ................................. 6
Extended Terms and Residency Requirements ........................................ 6
Postgraduate and Part II Lectures ....................................................... 7
Ordering Materials, Equipment, etc .................................................... 8
The Thesis ......................................................................................... 9
Extract from the Examination Regulations for the Honour School of Materials
Science Part II .................................................................................. 9
Marking the Part II Project .................................................................. 12
Extract from FHS Examination Conventions for Materials Science 2013-14 ... 13
Supervisor’s Report Form – Parts A & B ................................................. 15
MS Part II Thesis Assessment Report and Marking Guidelines ................. 17
MS Degree Final Mark Guidelines ........................................................ 20
What are the Examiners Looking for in a Good Part II Thesis? ............... 21
Plagiarism ....................................................................................... 23
Analysis of Errors .......................................................................... 28
Lab Books ...................................................................................... 28
Supervision and Training .................................................................. 29
Project Management ......................................................................... 30
  PROJECT MANAGEMENT FORM 1 .................................................. 34
  PROJECT MANAGEMENT FORM 2 .................................................. 35
  PROJECT MANAGEMENT FORM 3 .................................................. 36
The Part II Talk .............................................................................. 37
Prizes ............................................................................................. 37
Leaving the Department .................................................................... 38
Materials Science Part II Leavers: Destination Information .................... 39
Materials Science Part II Leaver’s Declaration ...................................... 40
Part II Organisation .......................................................................... 41
Appendix A: Part II Thesis Declaration of Authorship ............................ 42
Appendix B: Treatment of Experimental Errors, J.P. Jakubovics ............. 43
Appendix C: External MS Part II Briefing Notes .................................. 53
<table>
<thead>
<tr>
<th>Student</th>
<th>College</th>
<th>Project</th>
<th>Supervisor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorcha BOTWRIGHT</td>
<td>QNS</td>
<td>Self-assembly of peptides on surfaces</td>
<td>HEA</td>
</tr>
<tr>
<td>Nicholas BYRNE</td>
<td>STA</td>
<td>Superconducting thin films for highly efficient quantum resonators</td>
<td>SCS/CRMG</td>
</tr>
<tr>
<td>Ella CARLSON-O’CONNOR</td>
<td>CCC</td>
<td>Persistent mode joints between high temperature superconducting wires</td>
<td>SCS/CRMG</td>
</tr>
<tr>
<td>Megan CARTER</td>
<td>SEH</td>
<td>Aluminium alloys for aerospace/automotive applications</td>
<td>PAJB/MPM/Shollock</td>
</tr>
<tr>
<td>Victoria CARTWRIGHT</td>
<td>SEH</td>
<td>Detecting strain in scanning transmission electron microscope images</td>
<td>PDN/L Jones</td>
</tr>
<tr>
<td>Lova (Lev) CHECHIK</td>
<td>MAN</td>
<td>In-situ 3D observation of damage development and healing in a carbon fibre composite</td>
<td>TJM</td>
</tr>
<tr>
<td>Marcus COHEN</td>
<td>CCC</td>
<td>Novel photon capture methods for multicrystalline silicon</td>
<td>PRW/Hamer</td>
</tr>
<tr>
<td>Eleanor CROSSLEY</td>
<td>SEH</td>
<td>Atomic-scale characterisation of austenite decomposition within carbide-free bainitic steel</td>
<td>MPM/PAJB</td>
</tr>
<tr>
<td>Luke DENT</td>
<td>SEH</td>
<td>Flash processing of ceramics</td>
<td>RIT/Bonilla/PRW</td>
</tr>
<tr>
<td>Zhuoran (Roger) FANG*</td>
<td>TRI</td>
<td>Developing novel thin film phase change materials for photonic applications</td>
<td>Prof. Hu (MIT) / HB</td>
</tr>
<tr>
<td>Axel FORSSBERG*</td>
<td>STA</td>
<td>Oxygen redox activity in metal oxides for Li-ion batteries</td>
<td>Prof Yang Shao-Horn (MIT) / PGB</td>
</tr>
<tr>
<td>Tabitha JONES</td>
<td>MAN</td>
<td>Electrochemical gas sensors based on conducting polymers</td>
<td>MRC/Murugappan</td>
</tr>
<tr>
<td>Takashi LAWSON</td>
<td>SEH</td>
<td>Fabrication of nanoscale photonics and waveguides</td>
<td>HB/Rios</td>
</tr>
<tr>
<td>Ruiwen (River) LI*</td>
<td>STC</td>
<td>Spatially controlled expansion of hydrogels</td>
<td>JTC</td>
</tr>
<tr>
<td>Xiewen (Steven) LIU</td>
<td>STC</td>
<td>Drug delivery to the mucosal membrane</td>
<td>Dr. Caffarel (MIT) / HEA</td>
</tr>
<tr>
<td>Shiyun (Shawn) LIU</td>
<td>STA</td>
<td>New passivation processes for semiconductor surfaces</td>
<td>PRW/Bonilla</td>
</tr>
<tr>
<td>Xinlei (Ted) LIU</td>
<td>SEH</td>
<td>Electronic properties of metal-halide perovskites</td>
<td>FG/Filip</td>
</tr>
<tr>
<td>Anna MACDONALD</td>
<td>TRI</td>
<td>Next generation of solid-state lithium batteries electrolytes</td>
<td>MP/PGB</td>
</tr>
<tr>
<td>Harry MACPHERSON</td>
<td>TRI</td>
<td>N@C60derivatives for quantum computing</td>
<td>KP</td>
</tr>
<tr>
<td>Bethan MURRAY</td>
<td>CCC</td>
<td>Cyclic fatigue of zirconia ceramics</td>
<td>RIT</td>
</tr>
<tr>
<td>Miles PARTRIDGE</td>
<td>CCC</td>
<td>Synthesis and electrochemical characterisation of Na-battery materials</td>
<td>PGB/MP</td>
</tr>
<tr>
<td>Matthew ROBSON</td>
<td>STA</td>
<td>Development and testing of novel thermal bridges in F1 motors</td>
<td>NG</td>
</tr>
<tr>
<td>Rusheb SHAH</td>
<td>MAN</td>
<td>Predicting the structure of yttrium titanium oxide compounds from first principles</td>
<td>RJN/JRY</td>
</tr>
<tr>
<td>Eleanor SHAW</td>
<td>SEH</td>
<td>Defect engineering to increase the efficiency of multi-crystalline silicon solar cells</td>
<td>PRW/Hamer</td>
</tr>
<tr>
<td>Ashley SIM</td>
<td>QNS</td>
<td>Characterisation of gas-barrier polymer films</td>
<td>HEA</td>
</tr>
<tr>
<td>Stephen TURRELL</td>
<td>STC</td>
<td>High entropy alloys for extreme environments</td>
<td>DEJA/AJW</td>
</tr>
<tr>
<td>Tinger WEN</td>
<td>MAN</td>
<td>Ultrasonic microscale fatigue testing</td>
<td>AJW/Gong</td>
</tr>
<tr>
<td>David WINDMILL</td>
<td>CCC</td>
<td>Failure of armour ceramics in compression</td>
<td>RIT</td>
</tr>
<tr>
<td>Name</td>
<td>Designation</td>
<td>Title</td>
<td>Institute</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------</td>
<td>----------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Christopher WOODMAN</td>
<td>STA</td>
<td>Magnesium diboride materials for prototype benchtop MRI instruments</td>
<td>SS/CRMG</td>
</tr>
<tr>
<td>Denis ZABORONSKY</td>
<td>TRI</td>
<td>Why do strain-paths matter?</td>
<td>DMC/Tarleton</td>
</tr>
<tr>
<td>James ZHOU*</td>
<td>MAN</td>
<td>Differential capacitance of the electrical double layer with concentrated electrolyte solutions, and applications to supercapacitors.</td>
<td>Prof. S Perkin(Chem) /KP</td>
</tr>
</tbody>
</table>
Induction Course Schedule
Monday 12 September 2016, Hume-Rothery Lecture Theatre

0930 – 1030hrs

Keyna O’Reilly
Welcome and introductions. Purpose and overview of the day.

The Part II Project:
- Registration, extended terms and residency requirements.
- Postgraduate and Part II lectures.
- Ordering materials and equipment.
- The thesis.
- Deadline for thesis submission.
- The viva voce examination and marking the Part II project.
- What are the examiners looking for in a good Part II thesis?
- Plagiarism.
- Analysis of errors.
- Project Management (briefly).
- The Part II talk.
- Keeping a lab book.

1030 – 1040hrs

Neil Young
Electron microscopy training courses

1040 –

Coffee

+ Les Chorley

The workshop and signing up for the workshop practice course. The course is compulsory for all those doing their Part II in the Department.

Half of Part IIs have coffee, half go on a tour of the workshop – then swap over (Allowing 5mins @beginning, middle and end to walk to and from the Thom Building)

1125 – 1200hrs

Andrew Watt
Safety lecture.

1200 – 1230hrs

Paul Warren
Information technology in the Department:
Thursday 15 September 2016, Hume-Rothery Lecture Theatre

1330 – 1500hrs  
**Gerry Litchfield QinetiQ**  
Project Management and the Part II.

1500 – 1530hrs  
Coffee

1530 – 1650hrs  
**Gerry Litchfield QinetiQ**  
Project Management and the Part II

1650 – 1700hrs  
**Keyna O’Reilly**  
Departmental project management forms and concluding remarks.

Monday 26 September 2016, RSL Training Room

1000 – 1130hrs  
**Ljilja Ristic (OULS)**  
Information Skills for Part II students including an introduction to Reference Management

**Patent Literature workshop – probably in 7th week of MT (tbc)**

**LabView and MatLab: use in Materials research – HT (tbc)**
Other Transferable Skills Training & Related Topics

You may find it useful to attend some of the following workshops/events. For details see the on-line termly lecture list.

- Part II writing skills, plagiarism, laboratory notebooks, IPR & patents, HT, Prof Assender & others.
- Presentation skills, PowerPoint, modern A/V technology, PPT for posters, practical tips, HT, Mr Baker(OUCS) & Dr Taylor.
- The Oxford University Careers Service – Active job hunting, MT, Dr Evans.
- Careers & networking evening with alumni, MT.
- DPhil poster competition, HT.
- Technology and knowledge transfer, TT (tbc).

In addition, see the on-line MS & MEM FHS Handbook, section 8, for details of Foreign Language options that are available to you. **NOTE: REGISTRATION REQUIRED BY WEDNESDAY OF WEEK 1 MT.**

Extended Terms and Residency Requirements

Statutory residence of **37 weeks** (Examination Decrees and Regulations)

**Extended terms:**

**Michaelmas Term 2016**
Friday, 9 September - Saturday, 10 December

**Hilary Term 2017**
Friday, 6 January - Saturday, 8 Apr

**Trinity Term 2017**
Friday, 21 April - Saturday, 1 July
Postgraduate and Part II Lectures

You are strongly encouraged to attend any postgraduate lectures that you consider useful or interesting. A copy of this year’s Scheme is available on the Department’s website (http://www.materials.ox.ac.uk/teaching/lecturelists.html).

In particular, if you are planning to do any X-ray diffraction work then you should attend the ‘X-ray diffractometry’ course given by Prof. C.R.M. Grovenor.

If you wish to use any of the electron microscopes you must first receive training (and attend the relevant lectures), co-ordinated by Dr. N.P. Young.
Ordering Materials, Equipment, etc

- You should agree your request for consumables, materials etc. with your supervisor.

- For items held in the departmental stores you will need an account code. Each student will be allocated £50 total for minor consumables and your supervisor will give you a code that you can use in this respect. For further information on stores, please consult the following web address: www.materials.ox.ac.uk/local/stores.

- If the items are not held in stores you should complete a requisition form, obtainable from Department’s internal web pages at www.materials.ox.ac.uk/local/documents.html. The form is located under the ‘Purchasing, Finance Forms and Documents’ section. Before placing an order please read the notes ‘Purchasing Advice’ and ‘Requisitions, Orders and Equipment Purchasing Information’ also located under the ‘Purchasing, Finance Forms and Documents’ section. You may not place an order directly with a supplier.

- You MUST get your supervisor to sign the form, and state where the funding is coming from. (It will be returned otherwise!)

Some hints on how to order items correctly:

1. Please complete requisition forms properly. The name and address of suppliers, an account code from which the purchase will be funded, and an authorised signatory for the account code are all required. If the correct information is not supplied, the forms will be sent back to the originator.

2. Please do not make any subsequent changes to an order without consulting the Department’s Finance Office. It wastes a huge amount of time if the Finance Officer has to query invoices where you have made subsequent changes and not kept them informed. Any substantial changes require a new requisition form. If in doubt, please talk to Barry Fellows (Finance Officer) or the Deputy Administrator (Finance).

4. Please pass any delivery notes straight on to the Finance Office. Again, it wastes time if they have to chase these up.

5. Please reply as soon as possible to any queries raised by Barry regarding payment of invoices.
The Thesis

Extract from the Examination Regulations for the Honour School of Materials Science Part II

'Every candidate for Part II is required to submit three copies of a report on the investigations which he or she has carried out under the direction of his or her supervisor. The report on the investigations shall also include an abstract, a literature survey, a brief account of the project management aspects of the investigation, and a description of the engineering context of the investigation and should be accompanied by a signed statement by the candidate that it is his or her own work. The copies should be handed in to the Chair of the Examiners in the Honour School of Materials Science c/o Examination Schools, High Street, Oxford, not later than 4 p.m. on the Monday of the seventh week of Trinity Full Term. The report shall be word-processed or typewritten on A4 paper (within a page area of 247 mm x 160 mm, using double line-spaced type of at least 11pt font size, printed on one side only of each sheet, with a left hand margin of at least 30mm) and presented in a binder. The main report should not normally exceed 12,000 words together with a maximum of a further 1,500 words for the reflective account of the project management aspects of the investigation that must be included in the final chapter. These word counts exclude references, title page, acknowledgements, table of contents and the three Project Management Forms. All other text is included in the word count, including the abstract, tables and the figure captions. Additionally, the main report should not normally exceed 100 pages in length (including an abstract, the text as defined above for the word limits, the three Project Management Forms, computer programs, graphs, diagrams, photographs, tables, and similar material). All pages of the report should be numbered sequentially. The report must be accompanied by a signed declaration that it is within the allowed word and page limits. Candidates seeking permission to exceed the word and/or page limits should apply to the Chair of Examiners at an early stage. Further detailed data, computer programs and similar material may be included in one or more appendices at the end of the main report, but appendices are not included within the limits of the word or page counts of the thesis and, entirely at the discretion of the Examiners for each report, may or may not be read.'
**Word limit:** 12,000 words for the main body of the thesis, plus 1,500 words for the mandatory final chapter containing an account of the project management aspects of your investigation. Word counts exclude references, title page, acknowledgements, table of contents and the three project management forms. All other text is included in the word count, including the abstract, tables and the figure captions.

**Page limit:** 100 pages. Page count includes an abstract, the text as described in the word limits above, the three project management forms, computer programs, graphs, diagrams, photographs, tables and similar material. **All** pages of the thesis should be numbered sequentially.

If you feel that you have an exceptional case for exceeding the word and/or page limit, and you wish to seek permission to do so, both you and your supervisor should contact the Part II Project Organiser who will put your case to the Chair of Examiners. Such a case should be made at the earliest possible stage. The Examiners will enforce the word limit strongly, and any thesis submitted over the word limit may be subject to penalties.

**Appendices:** the purpose of the above word and page limits is to prevent the excessive inclusion of material that is unnecessary for development of the key argument(s) of the thesis. Material which is additional to the main body of the thesis, e.g. further detailed data, may be included in appendices. However, whilst Examiners are required to consider the main body of the thesis, whether they read appendices is entirely at their discretion.

The thesis **MUST** include:

- (i) a one-page abstract.
- (ii) a literature survey.
- (iii) a brief account of the Engineering Context/Relevance of your project (a requirement of Accreditation).
- (iv) a final chapter containing an account of the project management aspects of the investigation.
- (v) a signed statement by the candidate that it is his or her own work and that it adheres to the previously described word and page limits (See Appendix A: Part II Thesis Declaration of Authorship. A template for the Declaration of Authorship can be downloaded from WebLearn at [https://weblearn.ox.ac.uk/portal/hierarchy/mpls/materials/ug](https://weblearn.ox.ac.uk/portal/hierarchy/mpls/materials/ug)).
The thesis must be submitted to the Chair of the Examiners in the Honour School of Materials Science, c/o Examination Schools, High Street by 4.00 pm on **Monday of week 7 of Trinity Term**.

**THREE** copies must be submitted.

The thesis **MUST** be:

(i)  word-processed or typewritten on A4 paper. The text should fit within a page area of 247 mm x 160 mm (i.e. top and bottom margins totalling 50 mm, and left and right margins totalling 50 mm) with a left hand margin of at least 30 mm (for ease of reading after binding). The thesis should be printed/typed on one side of the paper only. The text should be double line-spaced. The typeface should be of at least 11pt size.

(ii)  presented in a binder. Paula Topping (Teaching labs) will assist with the binding in 7th week.

The **viva voce examination** is normally held in 9th or 10th week of Trinity Term. Please keep these weeks clear in your diary.

Following the formal submission of your thesis to the examiners, you are requested to submit to the Department Librarian 2 CD-Roms each containing an electronic version of your thesis. Please see the section on "Leaving the Department" later in this Handbook. This requirement is not a part of the formal examination process.
Marking the Part II Project

The Part II contributes a maximum of 400 marks towards the total of 1200 marks for the whole degree.

Your thesis will be read independently by two internal examiners, who will each allocate a provisional mark before the viva.

Those two marks are declared to all the examiners before the vivas begin.

Each thesis will be inspected by one of the two External Examiners.

After the viva the Part II Examiners discuss the marks from the two internal examiners and agree \textit{collectively} a mark out of 400.

\textbf{The examiners in the Department of Materials for 2016-17 are expected to be as follows:}

\textbf{Examiners for the Part II Examination}: Prof. Hazel Ascender, Prof. Martin Castell, Prof. Patrick Grant, Prof. James Marrow (Chair), Prof. Sergio Lozano-Perez, and Prof. Jonathan Yates. The external examiners are Prof. Alison Davenport, Birmingham, and Prof. Mike Reece, Queen Mary, University of London.

It must be stressed that in order to preserve the independence of the Examiners, you are not allowed to make contact directly about matters relating to the content of the exams or the marking of coursework. Any communication must be via the Senior Tutor of your college, who will, if he or she deems the matter of importance, contact the Proctors. The Proctors in turn communicate with the Chair of Examiners. If you have any queries about the Examinations or anything related to the Examinations, for example, illness, personal issues, please don’t hesitate to seek further advice from your College tutor, or one of the Department’s academic support staff.
3. PART II
The Part II project is assessed by means of a thesis which is submitted to the Examiners, who will also take into account a written report from the candidate’s supervisor. The marking criteria are published in the Part II Course Handbook.

The Supervisor’s report is divided into Parts A & B: Part A provides simple factual information that is of significance to the examiners, such as availability of equipment, and is seen by the two markers before they read and assess the thesis. Part A does not include personal mitigating circumstances which, subject to guidance from the Proctors, normally are considered only in discussion with all Part II examiners thus ensuring equitable treatment of all candidates with mitigating circumstances. Part B of the supervisor’s report provides her/his opinion of the candidate’s engagement with the project and covers matters such as initiative and independence; it is not seen by the examiners until the discussion held after the viva.

The project is allocated 400 marks, which is one third of the total marks for Parts I and II. Two Part II examiners read the thesis, including the project management chapter, together with Part A of the supervisor’s report, and each of them independently allocates a provisional mark based on the guidelines* published in the course handbook. In addition, normally the thesis will be seen by one of the two external examiners.

A viva voce examination is held: the purpose of the viva is to clarify any points the readers believe should be explored, and to ascertain the extent to which the work reported is the candidate’s. An examiners’ discussion is held after the viva, involving all Part II examiners, excepting any who have supervised the candidate’s Part II project or are their college tutor. During this discussion Part B of the supervisor’s report is taken into account. The outcome of the discussion is an agreed mark for the project. In arriving at the agreed mark the Examiners will take into account all of the following, (i) the comments and provisional marks of the original markers, (ii) the candidate’s understanding of their work as demonstrated during the viva and (iii) the opinion of the external examiner who has seen the thesis. It is stressed that it is the scientific content of the project and the candidate’s understanding of their work that is being considered in the viva.

If the two provisional marks allocated in advance of the viva differ significantly (that is, normally by more than 10% of the total available for the project) this will be addressed
explicitly during the discussion after the viva. In the majority of other cases, the viva has only a small influence on the agreed mark awarded to a Part II thesis.

If there are believed to be mitigating circumstances, such as illness, which may have affected the candidate’s progress with the project these should, in the normal way, be drawn to the attention of the Senior Tutor at the candidate’s college, who will, if appropriate, inform the Proctors. The Proctors may in turn communicate with the Chairman of Examiners about the mitigating circumstances. Subject to guidance from the Proctors, if appropriate the Board of Examiners will take into account these mitigating circumstances in their discussion after the viva.

* These guidelines may change and candidates are notified of any such changes before the end of Hilary Term of their 4th year.
Supervisor’s Report Form – Parts A & B

UNIVERSITY OF OXFORD
DEPARTMENT OF MATERIALS

Trinity 2016

From: Chairman of Examiners
To: Supervisors of MS Part II Projects
Return to: Deputy Administrator (Academic)

Please provide your assessment of the project which you have supervised. In the case of co-supervision please submit only one form (agreed by all supervisors) per candidate.

PLEASE ENSURE YOU COMPLETE BOTH PARTS A & B OF THIS FORM

This form must be returned by Tuesday 9th June (week 7)

Please complete the form electronically and send it to philippa.moss@materials.ox.ac.uk.

Supervisor/s:
Candidate Name: 
College: 
Project Title: 

MS Part II Supervisor’s Form - part A

Factual Information (to be read by examiners in conjunction with the candidate’s thesis)

i) To what extent does the project form part of a well-established research programme in your group, and what input has been received from other members of the group?

ii) What have the candidate’s own original contributions been, and in which sections of the thesis are they reported?

iii) Have there been major factors outside the candidate’s control that have significantly affected the progress of the work?

Signature and date .................................
(your signature confirms that all co-supervisors have been consulted prior to completion of this form)

PART B OF THIS FORM FOLLOWS ON THE NEXT PAGE
Supervisor/s:  
Candidate Name:  
College:  
Project Title:  

MS Part II Supervisor’s Form - part B

Supervisor’s Assessment (which may be made available to examiners when determining the candidate’s final classification)

Please give an overall assessment of the student’s work on the project including:
- the competence and application of the student;
- the quality of the student’s work;
- the balance between the student’s own input to the project and the assistance you or other members of the research team gave the student (including project planning and the write-up of the thesis)

If you supervised an externally placed student please ensure you incorporate comments from the external supervisor(s).

Signature and date ...........................................
(your signature confirms that all co-supervisors have been consulted prior to completion of this form)
MS Part II Thesis Assessment Report and Marking Guidelines

The guidelines outlined below were used by examiners in 2016 to assess theses.

Examiners should write a report of not more than two pages giving their assessment of the thesis, taking into account the marking guidelines overleaf, and including explicit comment under each of the headings 1-11.

<table>
<thead>
<tr>
<th>Name of Candidate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Aims &amp; Objectives</strong></td>
</tr>
<tr>
<td>What were the aims and objectives of the project? Are these clearly identified in the thesis?</td>
</tr>
<tr>
<td><strong>2. Project Management</strong></td>
</tr>
<tr>
<td>Is the account of project management clear? Does it show that the project was well managed? Were the original objectives kept to, and if they were changed, is it shown why?</td>
</tr>
<tr>
<td><strong>3. Engineering Context</strong></td>
</tr>
<tr>
<td>Has the candidate identified the engineering (or equivalent) context of the work?</td>
</tr>
<tr>
<td><strong>4. Literature Review</strong></td>
</tr>
<tr>
<td>Is the background literature to project reviewed adequately? (comprehensively, focused on the project's area and critically.)</td>
</tr>
<tr>
<td><strong>5. Methods (including data analysis methods)</strong></td>
</tr>
<tr>
<td>Are the methods and analysis of data used in the project clearly described? Did the student develop any new methods?</td>
</tr>
<tr>
<td><strong>6. Results</strong></td>
</tr>
<tr>
<td>Are the “raw” results attained clearly described? Are the results analysed adequately and appropriately? (if appropriate) Are errors handled adequately?</td>
</tr>
<tr>
<td><strong>7. Discussion</strong></td>
</tr>
<tr>
<td>Are the results properly discussed: in themselves? in relation to previous work in the area? in relation to the aims and objectives of the project?</td>
</tr>
<tr>
<td><strong>8. Main Achievements</strong></td>
</tr>
<tr>
<td>What do you consider to be the main achievements of the project? Are these clearly identified in the thesis?</td>
</tr>
<tr>
<td><strong>9. Weaknesses</strong></td>
</tr>
</tbody>
</table>

17
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicate any weaknesses which you may have found. Does the thesis show awareness of these?</td>
<td></td>
</tr>
<tr>
<td><strong>10. Originality</strong></td>
<td></td>
</tr>
<tr>
<td>Does the thesis show original thinking on the part of the student?</td>
<td></td>
</tr>
<tr>
<td><strong>11. Quality of Report</strong></td>
<td></td>
</tr>
<tr>
<td>Comment on the quality of the report. (use of English, overall style, quality of diagrams and figures, use of references to previous work, etc.)</td>
<td></td>
</tr>
<tr>
<td><strong>12. Additional Comments</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Overall Mark</strong></td>
<td></td>
</tr>
<tr>
<td>Give short justification for mark</td>
<td></td>
</tr>
</tbody>
</table>
The following anticipated guidelines will be used by the examiners to assign marks (in percentage terms) for the MS Part II Thesis:

90-100% Thesis rated very highly in all categories of the assessment guidelines. Typically this would be an extremely high quality thesis showing extensive evidence of original thought, results very well analysed and put in context, very well presented, and with no important deficiencies.

80-89% Thesis demonstrating very strong performance across most categories, with some minor weaknesses in one or two areas. Typically this would be a very high quality thesis showing evidence of original thought, results very well analysed and put in context, very well presented, but with some minor deficiencies.

70-79% Very strong overall performance, but with significant weakness in one or two categories or minor weaknesses in several. Typically this would be a high quality thesis showing some evidence of original thought, results well analysed and put in context, well presented. May be deficient in one or two areas accounting for a minority of the whole.

60-69% Strong overall performance, but with some weaknesses in several categories. Typically the work would have been competently carried out and reasonably well presented and analysed. This mark range should be achievable by an average student with reasonable effort.

50-59% Satisfactory overall performance, but with serious weaknesses in several categories. Typically the work would have been carried out mostly with competence, but with some flaws (e.g. errors, misinterpretations). Little evidence of original thought.

40-49% Poor overall performance with serious weaknesses in several categories. No evidence of original thought.

30-39% Poor overall performance with serious weaknesses in the majority of categories. The thesis of a candidate who has done little work and has presented this work poorly.

<30% Very poor performance with little or no meaningful content.
MS Degree Final Mark Guidelines

The final marks for the Materials Science degree in its entirety (Part I exams and coursework, and Part II) conform to the University’s standardised expression of agreed final marks, as follows:

<table>
<thead>
<tr>
<th>Marks</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>70-100</td>
<td>First Class (I)</td>
</tr>
<tr>
<td>60-69</td>
<td>Upper Second (IIi)</td>
</tr>
<tr>
<td>50-59</td>
<td>Lower Second (IIii)</td>
</tr>
<tr>
<td>40-49</td>
<td>Third (III)</td>
</tr>
<tr>
<td>30-39</td>
<td>Pass</td>
</tr>
<tr>
<td>0-29</td>
<td>Fail</td>
</tr>
</tbody>
</table>

With the qualitative descriptors for each classification level being:

**Class I**  The candidate shows excellent problem-solving skills and excellent knowledge of the material over a wide range of topics, and is able to use that knowledge innovatively and/or in unfamiliar contexts.

**Class IIi** The candidate shows good or very good problem-solving skills, and good or very good knowledge of much of the material over a wide range of topics.

**Class IIii** The candidate shows basic problem-solving skills and adequate knowledge of most of the material.

**Class III** The candidate shows reasonable understanding of at least part of the basic material and some problem solving skills. Although there may be a few good answers, the majority of answers will contain errors in calculations and/or show incomplete understanding of the topics.

**Pass**  The candidate shows some limited grasp of basic material over a restricted range of topics, but with large gaps in understanding. There need not be any good quality answers, but there will be indications of some competence.

**Fail**  The candidate shows inadequate grasp of the basic material. The work is likely to show major misunderstanding and confusion, and/or inaccurate calculations; the answers to most of the questions attempted are likely to be fragmentary only.
Let’s start with the obvious. What the examiners most want to see is high quality scientific work, professionally carried out and well presented. There is not a requirement in the regulations that you should discover something entirely new and revolutionary. You only have nine months to carry out your project, and one of the essences of scientific research is its unpredictability. You may run into unexpected difficulties, or the project may not work out at all in the way you anticipated. It may even happen that other people are working on the same scientific problem, entirely unknown to you, who publish their results shortly before you complete your own work. You have no control over such events. For this reason, the examination regulations require only that you submit a report on your investigations. Tell us what you did. If it worked, that’s great. If it didn’t, tell the examiners why, and if appropriate, suggest how the project might be improved or redesigned to get better results. If you find that other people have duplicated your work, you should include a critical comparison of your work and theirs. If the various results agree, that’s good: if not, that’s interesting – try to explain the reasons for the discrepancies.

Now to some details. The Part II year forms part of your training for the M.Eng. degree, and for subsequent Chartered Engineer status. Thus there are a number of professional skills that you should be acquiring during the year, and for which training will be provided. These include experimental and / or computational abilities, literature searching, data analysis, oral and written presentational skills, and project management. Your Part II thesis should demonstrate what you have learnt in a number of these areas. For example:

- Your literature survey should be concise and critical, and you should include mention of what databases or other information sources you have used in compiling it.
- An engineering context of your work also needs to be included.
- Full information should be given about the materials that you study – their source, purity, full composition, prior thermal and mechanical treatments, etc.
- The reproducibility of experimental measurements should be stated, and an estimate of experimental errors and uncertainties should be included alongside the results.
- Analysis of the statistical significance of experimental results should be included whenever appropriate.
- Where computer modelling has been used, an assessment of the reliability of the model and the accuracy of the calculations should be attempted.
- A short discussion [mandatory final chapter from 1 Oct 2007] of project management aspects of your research should be included, describing the evolution of the aims and objectives of the work, the chronology of what was actually done, and the reasons for any changes of strategy as the year progressed.
- The thesis should contain a clear summary of the main results and conclusions and (where appropriate) should identify key objectives for further work.

One aspect of the Part II which is not formally assessed for examination purposes is your development of oral presentational skills. You will give a talk about your project at a Departmental ‘mini-symposium’ which is held shortly after Easter, and there is a prize for the best presentation on that occasion. But the examiners will not take this oral presentation into account when awarding your degree. The reason is simple – some people are naturally much better talkers than others! For the same reason, although you will have a viva voce examination following the submission of your thesis, you will not be marked for your presentational skills on that occasion. The purpose of the viva is to establish that you fully understand the subject matter of your thesis, that you are conversant with the workings of the equipment or computer models that you have used, and that you have a good critical appreciation of the significance of your results.

In assessing the thesis, the examiners will seek information from the project supervisor(s) about the extent of your interaction with other people, the nature of your specific contributions to the overall research, and about the effects of factors outside your control. But it is important not to let the existence of this form of evaluation distort your behaviour pattern. Don’t hide away in a corner and refuse to talk to anyone about your work for fear of being penalised at the end of the year. Teamwork is vital, and discussing plans and ideas with colleagues is a very important and enjoyable aspect of research – it’s just that, at the end of the year, the examiners have to try to establish what contribution you have made to the overall work of the research group of which you have been a member.

Have a great year – the Part II should be one the most enjoyable parts of the whole course.
Plagiarism

This information can be applied to all aspects of assessment during the course.

In Section 8.8 of their Student Handbook, the University’s Proctors and Assessor draw attention to extremely important disciplinary regulations for all students related to plagiarism.

“All students must carefully read regulations 3, 4 and 5 in the Proctors’ Disciplinary Regulations for University Examinations, which make clear that:

- you must always indicate to the examiners when you have drawn on the work of others, using quotation marks and references in accordance with the conventions of your subject area
- other people’s original ideas and methods should be clearly distinguished from your own
- the use of other people’s words, illustrations, diagrams etc should be clearly indicated regardless of whether they are copied exactly, paraphrased or adapted
- material you have previously submitted for examination, at this University or elsewhere, cannot be re-used unless specifically permitted in the special Subject Regulations.

Failure to acknowledge your sources by clear citation and referencing constitutes plagiarism. The University’s description of plagiarism should be read carefully. That description includes a link to the University’s online course about understanding what plagiarism is, and how to avoid it. You are strongly advised to complete the course.

[www.ox.ac.uk/students/academic/guidance/skills/plagiarism](http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism)

[weblearn.ox.ac.uk/x/f4XeLu](http://weblearn.ox.ac.uk/x/f4XeLu)

The University reserves the right to use software applications to screen any individual’s submitted work for matches either to published sources or to other submitted work. In some examinations, all candidates are asked to submit electronic copies of essays, dissertations etc for screening by ‘Turnitin’. Any matches might indicate either plagiarism or collusion.

Although you are encouraged to use electronic resources in academic work, remember that the plagiarism regulations apply to online material and other digital material just as much as they do to printed material.

Guidance about the use of source materials and the preparation of written work is given in departments’ literature and on their websites, and is explained by tutors and supervisors. If
you are unclear about how to take notes or use web-sourced material properly, or what is acceptable practice when writing your essay, project report, thesis etc, please ask for advice.

If University examiners believe that material submitted by a candidate may be plagiarised, they will refer the matter to the Proctors. The Proctors will suspend a student’s examination while they fully investigate such cases (this can include interviewing the student). If they consider that a breach of the disciplinary regulations has occurred, the Proctors are empowered to refer the matter to the Student Disciplinary Panel. Where plagiarism is proven, it will be dealt with severely: in the most extreme cases, this can result in the student’s career at Oxford being ended by expulsion from the University."

Some Brief Guidance

Text
Take care when referring to the work of others. Not only are published words subject to plagiarism, but ideas and opinions can be plagiarised too. You should not allow the opinions and conclusions of others to appear to be your own or confused with your own criticism.


"The peak-aging time of Al-4wt.%Cu, aged at 463 K, was not altered by the addition of 20 wt.%SiCp. The particle size of the reinforcement and the matrix to reinforcement particle-size ratio did not affect the peak-aging time. This implies that, on a bulk scale, aging is not affected by the spatial distribution of the reinforcement, although it is likely to be affected locally."

Here is one example of the use of this extract:
Stone and Tsakiropoulos studied the aging of metal matrix composites based on Al-4wt%Cu containing 20wt% SiC particles [Stone & Tsakiropoulos, 1994]. The peak-aging time of Al-4wt.%Cu, aged at 463 K, was not altered by the addition of 20 wt.%SiCp. The particle size of the reinforcement and the matrix to reinforcement particle-size ratio did not affect the peak-aging time. This implies that, on a bulk scale, aging is not affected by the spatial distribution of the reinforcement, although it is likely to be affected locally.

The first sentence is fine and is properly referenced. However the rest is plagiarised because (i) it is directly copied from the original without being identified as a quote and (ii) the author has not attributed the opinion in the fourth sentence to the original authors.

A second example:

Stone and Tsakiropoulos studied the aging of metal matrix composites based on Al-4wt%Cu containing 20wt% SiC particles [Stone & Tsakiropoulos, 1994]. They showed that the addition of the reinforcing particles had no effect on the time for peak aging of the matrix at 463K. The implication of this is that whilst aging is likely to be affected locally by the dispersion of the particles, it is not affected macroscopically by the spatial distribution of the reinforcement.

This example is an improvement because the second sentence is now attributed to the original authors. The opinion in the final sentence is still plagiarised. This final sentence could be improved by

The authors concluded that the implication of this is that whilst aging is likely to be affected locally by the dispersion of the particles, it is not affected macroscopically by the spatial distribution of the reinforcement. This is a sensible conclusion.

because whilst the new author agrees with the original opinion/conclusion they have not passed it off as their own. A belt and braces approach might be:

The authors concluded, “This implies that, on a bulk scale, aging is not affected by the spatial distribution of the reinforcement, although it is likely to be affected locally” [Stone & Tsakiropoulos, 1994]. This is a sensible conclusion.

Quite often you will not be simply referring to a single piece of published work, but comparing & contrasting several reports of relevance to a particular point in your own document and then offering your own considered opinion on this previous work and/or comparing it with your own data and conclusions. The principles illustrated above in respect
of Stone & Tsakiropoulos of course still apply to this more complicated case and in addition it is necessary to separately identify each contribution, for example:

It has been reported by two groups that the time for peak aging of the matrix at aging temperatures in the range 460-475K is not affected by the addition of reinforcing particles [Stone & Tsakiropoulos (1994), Bloggs & Jones (1997)]. Although a more recent study did observe an apparent influence of the reinforcing particles [Smith (2006)], in the present work we have been unable to reproduce this effect, our data being fully consistent with the original work of Stone & Tsakiropoulos. It seems likely that the results reported by Smith were an artefact of the analytical method that they adopted, such artefacts having been observed by others in related studies of a series of Al-Cu-Mg alloys [Jones et al (1999)].

Figures
Figures too are a potential source of plagiarism. If you use somebody else's diagram, graph, photograph or other artwork without acknowledging the original source then you are guilty of plagiarism (and possibly also of breach of copyright). If you use a figure from elsewhere then you should cite the original reference in the figure caption and in the associated body text. Even if you redraw a figure then you should still refer to the original source, e.g. [redrawn from Jones et al, 2006]. If you use a collection of data from other works to create a completely new figure (e.g. a graph to show a trend arising from a collection of data from several sources) then you must acknowledge the original data sources.

Why is referencing important?
Quite apart from the need to avoid plagiarism because of the danger that this may invalidate a piece of assessed work and/or lead to some other penalty, there are a number of other good reasons for the internationally accepted practise of using references in a factual document:

(i) It is a simple professional courtesy to a fellow scientist who has laboured long & hard to generate the work that you are referring to.

(ii) It enables the reader to verify the statements that you are making, to make his/her own judgements on both the conclusions that you report from the referenced work and the judgements that you make on this work, and of course to learn more about the detail of the original work.

(iii) Your work is strengthened by its reference to respected authorities in a given field; as scientists we all build our work 'on the shoulders of giants'.
(iv) It enables the reader to identify very clearly what are your own original contributions to the matters discussed. Since these contributions will undoubtedly be erudite and valuable, you will want the world to know that they are yours and to be able to give you credit for them when your work is referenced in the future!

The two main referencing systems are Harvard (author name, year of publication) and Vancouver (numbered sequentially in order of use). Whichever system you decide to use, good practice dictates that references should include (depending on publication type): authors, title of book or article, title of journal or other work, name of conference, place of publication, date of publication, publisher and page numbers. The conventions for citing internet resources include URL and date accessed. Your tutor will be able to provide further guidance.

Other useful information on plagiarism can be found on the Education Committee (EdC) web pages at http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism
Analysis of Errors

A former external examiner, Professor Goodhew of Liverpool University, commented in his report on the:

'almost complete absence of sensible estimates of experimental errors, or any careful attempts to assess the reproducibility of individual data points.'

There was also a:

'complete absence of use of any form of statistical analysis or even proper curve fitting in order to establish confidence limits for results.'

He concluded that:

'critical judgement was seriously lacking.'

Remedies:

1. Handout from Dr Jakubovics (see Appendix B of this Handbook).

2. Analysis of experimental measurements lecture course given to 2nd year MS and MEM students (which you may attend again if you wish to do so).

Lab Books

AIM: To enable you to keep a complete record of everything that you do in your Part II project.

Extremely useful for writing up.

Good scientific practice - very common in industry and academe to document procedures, results and analysis, and to maintain traceability of records, and to safeguard IPR.

You will be provided with a lab book free of charge. Your supervisor may expect to retain your lab book or a copy of it at the end of the project.

They will not be used for examining purposes.
Supervision and Training

The following teaching norm has been adopted by the Department of Materials for the supervision of MS Part II projects:

"Responsibility for the project rests with the student, who should be proactive in seeking support and guidance when necessary and in making use of existing written resources. MS Part II students should expect to hold regular meetings with their supervisor. These will normally be held at least every two weeks for the duration of the project but significantly more intensive support is usual in the initial and final stages of the project. The support given by the supervisor at these scheduled meetings may include formal discussion of research, feedback on the student’s derivations, analyses of results, thesis drafts etc. that have been read by the supervisor and direction to relevant literature. You are entitled to receive thorough feedback on one draft of your thesis provided that it is submitted to your supervisor significantly in advance of the deadline for submission of the thesis to the Examination Schools; feedback may not be possible if the draft thesis is submitted later than two weeks before this deadline. If a first draft is submitted to your supervisor well in advance of the final deadline then he or she is permitted, but not required, to provide limited feedback on revised drafts. Supervisor meetings will often be supplemented by brief discussions of particular aspects of the research on an ad hoc basis, as required for the investigation to progress smoothly. Further support will be given in the techniques required for the student to carry out their research. Examples include the use of equipment and the performance of experimental techniques, training on modelling software and computer programming and tuition in mathematical methods. Students should note that (i) it is in the nature of research that not all projects require the same type or level of support, and (ii) for some projects the supervisor will personally deliver specialist training, whilst for others such training will be provided by informal mentors or via scheduled Departmental training courses."
Project Management

The Part II Project is the first time that you have to focus on a full-time, self-driven piece of work for such a lengthy period. You are expected to take control of, and responsibility for, your own projects. For some this can be a daunting prospect. To help you, and to provide some development of what is a useful generic skill, there is a workshop on project management as part of the Part II induction programme (the slides are available for review at www.materials.ox.ac.uk/teaching/part2/pt2projectmanagement.html), and there is a formal Part II project management process which all students must undertake.

Why is project management important?

- Setting goals. Identifying your goals and objectives at the beginning of your project helps you to focus and remain focussed on what you aim to achieve. You wouldn’t want to get on a flight to New York only to realise half-way across the Atlantic that actually you should have been going to Paris!

- You have a pre-determined, fixed deadline. Planning what tasks you need to carry out, how long each will take, and the order in which you will do them will help you to understand if your goals are realistic, and to achieve them efficiently and on time. Avoid ‘two steps forward, one step back…’

- Planning resources. A carefully planned sequence of tasks will mean little if you haven’t thought about what you will need to carry out each of those tasks. Identifying what resources you will need (consumable items, equipment bookings, technical staff time, training etc), and having them in place at the right time is crucial. Consider also the availability of resources when scheduling your activities, e.g. the basic SEMs normally available to Part II students will be essentially unavailable during the Characterisation of Materials module (wks 1 & 2 of HT).

- Assessing and mitigating risks. It is in the nature of research that things can and do go wrong, e.g. suppliers fail to deliver, a technician that is helping you falls ill, or an instrument breaks down. Many of these things are outside of your control, but thinking in advance about the risks to the success of your project will help you to plan what to do if something does go wrong. Expect the unexpected.
- Monitoring progress. Having a pre-determined project schedule provides you with a means of continuously monitoring your own progress. Setting yourself milestones also helps you to keep on track. Although ‘following your nose’ can be fun, it’s easier to navigate by checking where you are in relation to landmarks on a map.

- Self-control. If left unchecked, your scientific curiosity may lead you along a variety of side-paths, some of which will be dead ends, and some of which may lead to very interesting but irrelevant outcomes. Effective project management will help you to resist that temptation, or at least help you to consider any risks to your project, and to re-plan, if you do decide to take a detour.

**The Formal Part II Project Management Process**

You are required to complete three 1-page forms through your Part II, and send them to the Deputy Administrator (Academic) (please retain copies for yourself and your supervisor(s)). These forms should be downloaded from WebLearn (see Forms / Part II) and are also available on the Department’s internal web pages at [www.materials.ox.ac.uk/teaching/part2/pt2projectmanagement.html](http://www.materials.ox.ac.uk/teaching/part2/pt2projectmanagement.html). Examples of these forms can be seen on the pages 34, 35 & 36. When completing these, you may wish to consider that you will need to include a copy of each in your thesis, so you should ensure they are legible and succinct!

The Part II Project Organiser will review the forms, and if your project is falling on stony ground then the Part II Project Organiser will invite you for a discussion, possibly with your supervisor.

**Project Management Form 1** (due Fri 0th wk MT) asks you to set out what you expect to achieve during your project, how you expect to achieve it and what resources you will need to achieve it.

**Project Management Forms 2** (due Fri 6th wk MT) and **3** (due Fri 6th wk HT) provide you with an opportunity to reflect on your progress, and to describe any difficulties you are experiencing and how you intend to resolve them.

Please take the management of your project and the completion of the Project Management forms seriously. Be honest with yourself and with us. Don’t tell us what you think we want to hear. By all means discuss the completion of the forms with your supervisor, but you should not allow them to influence your responses unduly.
Please do not feel that you have to wait until the next Project Management form is due before you can raise any issues that you are concerned about. Your supervisor is normally your first port of call, but you should feel free to discuss any matters of concern with the Part II Project Organiser at any time.

**Project Management and the Part II Thesis**

Assessment of your ability to manage your project is an integral part of the Examiners’ overall evaluation of your thesis. The Examination Regulations require that your Part II thesis includes a compulsory final chapter on the project management aspects of your investigation. The chapter should include a reflective account, of no more than 1,500 words, of how you managed your project and copies of the three project management forms which you may refer to in the reflective account.

It is important that you provide in this compulsory chapter a good description of the way in which you managed your project in order that the scientific fruits of your labour could be borne. The following are some ideas that might help you to plan this chapter (N.B. they are not exhaustive and should not be considered as template):

- Remind the Examiners of your initial objectives and what milestones you set yourself to achieve along the way. Note down whether you achieved those milestones in time. If not, why not?

- Were your early results in-line with your original hypothesis/objectives, or did they suggest an alternative path for your project (as much as we can plan, research projects often turn out to have a strong evolutionary element).

- In the early stages, did you think about what might go wrong and have a set of mitigating back-up plans. Did the things you thought might go wrong actually go wrong? Were you successful in putting your predetermined back-up plan into action?

- Did unexpected things go wrong? How did you cope with them?

- Did you plan what resources (raw materials, consumables, access to equipment and laboratories, other people’s time) you were going to need in advance? How did you ensure that they were all available to you at the right time? Were there any circumstances outside of your control that put those resources out of reach?
• How did you go about making decisions about your project? Did you take autonomous decisions, or did you take decisions only after consultation with your supervisor(s)? Did you have regular review meetings with your supervisor(s)? Were your meetings more ad-hoc as and when problems arose?

• Describe whether you essentially worked alone or as part of a group. If you worked as part of a group describe your role in that group, and how you ensured other members of your group carried out their roles in helping you achieve your aims.

• You might want to describe how you planned to write your thesis. Did you wait until you had done all of your practical work before starting your thesis, or did you draft sections as you went along? Did you use your lab book to help you write your thesis?

• Finally, you might also like to reflect on the planning and management of your project, and show the examiners that you have used this opportunity as a learning experience for the future; e.g. with the benefit of hindsight are there any aspects of your project that you now realise could have been better planned or managed.
PROJECT MANAGEMENT FORM 1

Part II Project Description Form

After discussion with your supervisor YOU should complete this form and send a copy to the Assistant to the Deputy Administrator (Academic) by Friday of 0th week of Michaelmas Term.

Name: 

College: 

Address for correspondence: 

Contact telephone number: 

Title of project: 

Supervisor: 

What are the objectives of the project in order of priority? 

List the major milestones that must be accomplished in order to meet the objectives of the project

Are you working essentially on your own or as part of a team? If you are part of a team what is your role, and to what extent is the success of your project dependent on other members of the team?

What resources (equipment, materials, technician support etc.) will you need?

Do you require any training to meet your objectives, e.g. in the use of specific experimental equipment or software, and how are you going to obtain that training?

Complete the following plan for your entire project as you see it now. List each major task down the left hand column, and for each one draw a horizontal line to indicate the period you expect to allocate to it. For example, the final task, writing your thesis, is shown as occupying mid-April to mid-June.

<table>
<thead>
<tr>
<th>Task</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Writing up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>xxxxxx</td>
</tr>
</tbody>
</table>

Has your supervisor completed a Risk Assessment Form about your project yet?

Your signature: 

Your supervisor’s signature: 

Date: 

Date:
PROJECT MANAGEMENT FORM 2

1st Part II Project Analysis Form

Complete this form and send a copy to the Assistant to the Deputy Administrator (Academic) by Friday of 6th week of Michaelmas Term

Name:
Title of Project as given in your Project Description:

Refer back to the project plan in your Project Description and list the goals you set for this term. Comment briefly on the extent to which you have achieved them.

Identify clearly any difficulties you have encountered. Are they surmountable in the time available?

State any refinements, modifications or replacements of the original objectives for your Part II project:

Are you intending to change the title of your project? If so, state the new title:

Have the training needs you identified in the Project Description been met, and have you identified any further training requirements?

Tick the appropriate box. Do you have

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Some</th>
<th>Sufficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis of results</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you have any other comments you wish to make?

After looking at the project plan in your Project Description complete the following project plan for the remainder of your Part II.

<table>
<thead>
<tr>
<th>Task</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Writing up</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
<td>xxxx</td>
</tr>
</tbody>
</table>

General comments by the supervisor:

Your signature: Your supervisor’s signature:
Date: Date:
PROJECT MANAGEMENT FORM 3

2nd Part II Project Analysis Form

Complete this form and send a copy to the Assistant to the Deputy Administrator (Academic) by Friday of 6th week of Hilary Term

Name:

Title of Project:

Refer back to the project plan you made last term and list the goals you set for this term. Comment briefly on the extent to which you have achieved them.

Identify clearly any difficulties you have encountered. Are they surmountable in the time available?

State any refinements, modifications or replacements of the objectives you set for your Part II project:

Are you intending to change the title of your project? If so, state the new title:

What is the title of the talk you will give to the Department?

Have all your training needs for this project now been met?

Tick the appropriate box. Do you have

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Some</th>
<th>Sufficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analysis of results</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you have any other comments you wish to make?

General comments by the supervisor:

Your signature:  
Date:  

Your supervisor’s signature:  
Date:
The Part II Talk

You will be required to give a talk on your Part II project at a mini-symposium in early Trinity Term.

No exemptions.

AIM: To give you experience of giving an oral presentation

Each talk will last 12 minutes + 3 minutes for discussion.

All members of the Department are invited.

The talk is not examinable! Part II examiners are allowed to attend only presentations of projects that they supervise.

You will receive brief, confidential, feedback about your talk from the Part II Project Organiser.

The talk should be aimed at non-specialist scientists. It should include a brief description of the engineering relevance of your project.

Prizes

Part II Talks
There is a prize of £450 and a medal from The Worshipful Company of Ironmongers for the best talk.

Best Project
Armourers and Brasiers’ Company Medal and Prize: The Armourers and Brasiers’ Company award a medal and a prize of £250 for the best MS Part II project.

The award is based on the recommendation of the Part II examiners, after the examination of the Part II thesis is completed.

The Armourers like to award the prize and medal at a formal presentation by one of their senior people, on a public occasion.
Leaving the Department

In the closing stages of the course you will be asked to complete two Part II Leavers Forms

**Part II Leavers Form A**
Form A relates to sponsorship and vacation work whilst on course, and your onward career. This information is very important for various audits and assessments that the University and Department are subject to; for instance accreditation by IOM3.

You must hand Form A to Paula Topping (Teaching labs) when you have your thesis bound.

**Part II Leavers Form B**
Form B is a declaration that you have returned your library books and keys, and handed in your Form A and the electronic version of your thesis. You should have each field of this form initialled on behalf of the Department by the named individual.

Both forms are shown on the following pages and are available on WebLearn. They will be sent to you towards the end of Trinity Term with further instructions.

**Graduate Entrepreneur Visa Endorsement**
International students may be interested to know of the Tier 1 (Graduate Entrepreneur) category for the UKBA points based system, under which Oxford University may endorse a small number of graduates who have ‘genuine and credible business ideas and entrepreneurial skills, to extend their stay in the UK after graduation to establish one or more businesses in the UK’.

Further details about this are available through Career Connect - visit [http://www.careers.ox.ac.uk/our-services/careerconnect/](http://www.careers.ox.ac.uk/our-services/careerconnect/) to register. For information on the Tier 1 (Graduate Entrepreneur) visa and eligibility please visit the UKBA website: [http://www.ukba.homeoffice.gov.uk/visas-immigration/working/tier1/graduate-entrepreneur/](http://www.ukba.homeoffice.gov.uk/visas-immigration/working/tier1/graduate-entrepreneur/).
<table>
<thead>
<tr>
<th>Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Email:</td>
<td></td>
</tr>
<tr>
<td>Telephone No:</td>
<td></td>
</tr>
<tr>
<td>Address for forwarding mail (if possible, please provide an address relevant for the long-term)</td>
<td></td>
</tr>
</tbody>
</table>
| What are your plans for the next year? | □ Job  
Where?  
Start Date:  
Starting Salary (only if you wish to provide):  
□ Training  
Where?  
Start Date:  
□ Further research  
Where?  
Start Date:  
□ Other  
Please give details: |
| Please indicate if these plans are contingent on your degree results: | □ Conditional  
□ Unconditional  
Comments: |
| Please provide details of any industrial experience prior to coming to Oxford: | |
| Were you sponsored as an undergraduate? | □ Yes  
By whom?  
□ No |
| Were you involved in any vacation work that proved relevant to your study or future aspirations? | □ No  
□ Yes  
Where:  
For how long?  
Type of activity:  
Please provide contact details for any company that you would recommend to future students for a summer placement: |

Please complete all fields. If you are unable to complete a field then please enter “Not applicable” or “Do not know” or “Confidential” rather than leaving it blank.

Signed: ..............................................  Date: ..............................................

This form must be handed in when binding your thesis – many thanks for providing the information.
## Materials Science Part II Leaver’s Declaration

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Statement</th>
<th>To whom</th>
<th>Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form A</strong></td>
<td>I have returned Form A to provide contact details, forwarding address, destination information, etc</td>
<td>Paula Topping</td>
<td></td>
</tr>
<tr>
<td><strong>Laboratory Workspace</strong></td>
<td>I have cleaned my laboratory workspace and correctly labelled any chemicals and samples that I have left behind. I have disposed of any excess chemicals / samples safety and through the appropriate channels. (Note: you will need to contact Mimi to arrange a time for her to assess your laboratory workspace.)</td>
<td>Mimi Nguyen</td>
<td></td>
</tr>
<tr>
<td><strong>IT matters</strong></td>
<td>I have followed the advice on the Department’s <a href="#">website</a> concerning email account and IT matters; I have spoken to my supervisor about backing up my electronic data. (Contact IT Support if you have any further queries)</td>
<td>Part II supervisor</td>
<td></td>
</tr>
<tr>
<td><strong>Restricted Content in Thesis</strong></td>
<td>I sign over to my Part II supervisor (or responsible member of the Department, as appropriate) the rights to lift or retain the embargo on any restricted content. (Note: this section to be completed only if thesis content has been restricted.)</td>
<td>Part II Supervisor</td>
<td></td>
</tr>
<tr>
<td><strong>Library Books</strong></td>
<td>I have returned all library books</td>
<td>Grace Sewell</td>
<td></td>
</tr>
<tr>
<td><strong>Digital Part II thesis</strong></td>
<td>I have submitted to the Dept Librarian two CD-ROMS containing a digital version of my Part II thesis.</td>
<td>Grace Sewell</td>
<td></td>
</tr>
<tr>
<td><strong>Keys</strong></td>
<td>I have returned any keys to Reception. (Note: this must be done by the end of June.)</td>
<td>Receptionist</td>
<td></td>
</tr>
</tbody>
</table>

Leaver’s Signature: ........................................ Date: ................

This form must be returned to the Receptionist when you return your key.
Part II Organisation

Part II Project Organiser:
Prof Keyna O’Reilly
Room 10.02, 21 Banbury Road
Phone: (2)73743
keyna.oreilly@materials.ox.ac.uk
(Please e-mail me in the first instance)

Administrators for Part II Projects:
Deputy Administrator (Academic)
Ms Philippa Moss
Room 30.05, Hume-Rothery
Phone: (2)73750
philippa.moss@materials.ox.ac.uk

Interim Assistant to Deputy Administrator (Academic)
Ms Toni Perrott
Room 30.07, Hume-Rothery
Phone: (2)73703
antonia.perrott@materials.ox.ac.uk
Appendix A: Part II Thesis Declaration of Authorship

FINAL HONOUR SCHOOL OF MATERIALS SCIENCE

DECLARATION OF AUTHORSHIP

Candidates for the Part II examination of the Final Honour School of Materials Science should complete this declaration. A freshly signed declaration should be bound, immediately after the title page, into each copy of the thesis submitted for examination.

Name (in capitals): ___________________________ Candidate number: ___________________________

Supervisor(s): ___________________________ College: ___________________________

Title of Part II thesis (in capitals): ___________________________

Word count (main report): ___________________________ Word count (project management): ___________________________

There is extensive information and guidance on academic good practice and plagiarism in the course handbook and on the University website: www.ox.ac.uk/students/academic/goodpractice/

Please tick to confirm the following:

☐ I have read and understood the University’s disciplinary regulations concerning conduct in examinations and, in particular, of the regulations on plagiarism (Essential Information for Students. The Proctors’ and Assessor’s Memorandum, Section 5.4; also available at http://www.admin.ox.ac.uk/proctors/info/pam/).

☐ I have read and understood the Education Committee’s information and guidance on academic good practice and plagiarism at www.ox.ac.uk/students/academic/goodpractice/

☐ The thesis I am submitting is entirely my own work except where otherwise indicated.

☐ It has not been submitted, either partially or in full, for another Honour School or qualification of this University (except where the Special Regulations for the subject permit this), or for a qualification at any other institution.

☐ I have clearly indicated the presence of all material I have quoted from other sources, including any diagrams, charts, tables or graphs.

☐ I have clearly indicated the presence of all paraphrased material with appropriate references.

☐ I have acknowledged appropriately any assistance I have received in addition to that provided by my supervisor.

☐ I have not copied from the work of any other candidate.

☐ I have not used the services of any agency providing specimen, model or ghostwritten work in the preparation of this thesis. (See also section 2.4 of Statue XI on University Discipline under which members of the University are prohibited from providing material of this nature for candidates in examinations at this University or elsewhere: http://www.admin.ox.ac.uk/statutes/352-051a.shtml.

☐ I have not exceed the page limit as defined in the Examination Regulations

☐ I agree to retain an electronic copy of this work until the publication of my final examination result, except where submission in hand-written format is permitted.

☐ I agree to make any such electronic copy available to the examiners should it be necessary to confirm my word count or to check for plagiarism.

Candidate’s signature: ___________________________ Date: ___________________________

42
Appendix B: Treatment of Experimental Errors, J.P. Jakubovics

1. Introduction

Results obtained by experiments are never perfectly accurate, and therefore they are only meaningful if their accuracy can be estimated. The accuracy is expressed in the form of a quantity called the error, which is a measure of the lack of accuracy of the measurement. If the result of an experiment is the magnitude of some quantity, then it is just as important to estimate the error in this quantity as it is to calculate the quantity itself.

The following notes contain a summary of the basic points necessary for undergraduate practical work. For more details, reference should be made to textbooks. An excellent introduction to the subject at an elementary level is Errors of Observation and their Treatment by J. Topping (Chapman and Hall).

These notes deal with the estimation of random errors (those that are equally likely to occur with positive or negative sign). In any experiment, there might also be systematic errors (those that have a bias towards occurring with the same sign). Systematic errors cannot be treated by statistical methods, and it is therefore important to eliminate them at the experimental stage, or to calculate their effect afterwards.

2. The error in a measured quantity

Suppose a measurement is made of a quantity \( x \) whose actual value is \( x_0 \). This actual value can never be precisely established by experimental measurements. The result of the measurements might be a quantity \( x_m \). Suppose that the error in \( x_m \) has been estimated to be \( \varepsilon \).

This does not mean that the actual value \( x_0 \) is definitely between \( x = x_m - \varepsilon \) and \( x = x_m + \varepsilon \), and cannot be outside that range. Neither does it mean that \( x_0 \) is equally likely to be anywhere in the range \( x = x_m - \varepsilon \) to \( x = x_m + \varepsilon \). What it does mean is that there is a certain probability \( p \) (say 50% or 80%) that \( x_0 \) is in the range \( x = x_m - \varepsilon \) to \( x = x_m + \varepsilon \), and that the probability that \( x_0 \) is outside that range is \( 1 - p \). Moreover, the probability that \( x_0 \) is between \( x = x_m - 2\varepsilon \) and \( x = x_m + 2\varepsilon \) is higher than \( p \), and the probability that \( x_0 \) is between \( x = x_m - 3\varepsilon \) and \( x = x_m + 3\varepsilon \) is even higher. The meaning of \( x_m \) is that it is the most probable value of \( x_0 \). In most cases of practical interest, \( p \) varies with \( x \) according to a Gaussian law.
\[ p = A \exp \left[ -\frac{(x - x_0)^2}{2\sigma^2} \right]. \]  

(1)

Eq. (1) means that the probability that the result of a measurement will be between \( x \) and \( x + dx \) is \( p(x)dx \), and is called the Gaussian or normal distribution. We see that

1. \( p \) is a maximum when \( x = x_0 \),

2. \( \sigma \) is a measure of the ‘sharpness’ of the peak at \( x = x_0 \). The smaller \( \sigma \), the more rapidly \( p \) decreases with increasing difference between \( x \) and \( x_0 \). Therefore, \( \sigma \) is related to the error \( \varepsilon \) in some way. The relationship between \( \varepsilon \) and \( \sigma \) is discussed below.

3. The total probability must be 1, so that \( A \) is given by the condition

\[ \int_{-\infty}^{\infty} p \, dx = 1. \]  

(2)

It can be shown that this condition gives

\[ A = \frac{1}{\sigma \sqrt{2\pi}}. \]  

(3)

Of course, to establish the exact form of the probability function would need an infinite number of independent measurements of the quantity \( x \). But even with only a finite number of measurements, we can make a reasonable guess. Suppose we have made \( n \) measurements whose results are \( x_1, x_2, x_3, \ldots, x_n \). The most likely value of the ‘actual result’ \( x_0 \) is the arithmetic mean \( x_m \) of the measurements:

\[ x_m = \frac{x_1 + x_2 + x_3 + \ldots + x_n}{n}. \]  

(4)
We can therefore regard $x_m$ as the ‘result of the experiment’. Now consider the quantities

$$\delta_1 = x_1 - x_m, \quad \delta_2 = x_2 - x_m, \quad \ldots$$

(5)

The $\delta$-s are called the deviations, and the best guess we can make for $\sigma$ is

$$\sigma = \left( \frac{\delta_1^2 + \delta_2^2 + \delta_3^2 + \ldots + \delta_n^2}{n-1} \right)^{1/2}.$$  

(6)

The quantity $\sigma$ is called the standard deviation. Note that as we make more and more measurements of $x$ (i.e. as $n \to \infty$), $\sigma$ does not keep decreasing, but tends to a constant value. It is a measure of how much an individual measurement is likely to differ from $x_m$. The error, however, is a measure of how much $x_m$ is likely to differ from the ‘actual value’ $x_0$, and this error must obviously get smaller as $n$ increases. It is usual therefore to define the error by the expression

$$\epsilon = \frac{\sigma}{\sqrt{n}} \quad \text{or} \quad \epsilon = \left[ \frac{\delta_1^2 + \delta_2^2 + \delta_3^2 + \ldots + \delta_n^2}{n(n-1)} \right]^{1/2}$$

(7)

which is called the standard error.

3. Superposition of errors

In many cases, the quantity of interest is not directly measured, but is calculated from a formula that contains several directly measured quantities. In general, we calculate a quantity $y$ from a formula

$$y = f(x_1, x_2, \ldots, x_n),$$

(8)
where \( x_1, x_2, \ldots, x_n \) are the experimentally measured quantities. Suppose we have determined the errors in \( x_1, x_2, \ldots, x_n \) by using the formulae in the previous section, having made repeated measurements of each of the quantities. Let the errors in \( x_1, x_2, \ldots, x_n \) be \( \delta x_1, \delta x_2, \ldots, \delta x_n \) respectively. Then according to the ‘chain rule’, the error \( \delta y \) in \( y \) should be

\[
\delta y = \frac{\partial y}{\partial x_1} \delta x_1 + \frac{\partial y}{\partial x_2} \delta x_2 + \ldots + \frac{\partial y}{\partial x_n} \delta x_n,
\]

provided \( \delta x_1, \delta x_2, \ldots, \delta x_n \) are sufficiently small. However, if we use this formula to find \( \delta y \), we would be taking too pessimistic a view of the accuracy of the result. In effect, we would be assuming that all the errors \( \delta x_1, \delta x_2, \ldots, \delta x_n \) occur with the same sign. However, since these errors are random, there is an equal probability for each of them to be positive or negative. In order to take this randomness into account, we consider what happens when we square the expression for \( \delta y \):

\[
(\delta y)^2 = \left( \frac{\partial y}{\partial x_1} \right)^2 (\delta x_1)^2 + \left( \frac{\partial y}{\partial x_2} \right)^2 (\delta x_2)^2 + \ldots + \left( \frac{\partial y}{\partial x_n} \right)^2 (\delta x_n)^2
\]

\[
+ 2 \left( \frac{\partial y}{\partial x_1} \right) \left( \frac{\partial y}{\partial x_2} \right) \delta x_1 \delta x_2 + \ldots + 2 \left( \frac{\partial y}{\partial x_{n-1}} \right) \left( \frac{\partial y}{\partial x_n} \right) \delta x_{n-1} \delta x_n
\]

Clearly, the squared terms will always be positive, whether the \( \delta x \)-s are positive or negative. However, each of the cross-product terms can change sign if either of the \( \delta x \)-s it contains changes sign. Thus, there is an equal probability for any of the cross-product terms to be positive or negative. We are justified in assuming that the average value of each cross-product term is zero. The correct expression for the error in \( y \) is therefore

\[
\delta y = \left[ \left( \frac{\partial y}{\partial x_1} \right)^2 (\delta x_1)^2 + \left( \frac{\partial y}{\partial x_2} \right)^2 (\delta x_2)^2 + \ldots + \left( \frac{\partial y}{\partial x_n} \right)^2 (\delta x_n)^2 \right]^{1/2}.
\]

4. Examples

Here are two simple examples of the use of Eq. (11).

1. An aircraft is flying west, and its windspeed indicator registers a speed of \( v_1 \pm \delta v_1 \). The weather report gives an easterly wind of speed \( v_2 \pm \delta v_2 \). Then the speed of the aircraft relative to ground is
\[ V = v_1 + v_2. \]  \hfill (12)

Since

\[ \frac{\partial V}{\partial v_1} = \frac{\partial V}{\partial v_2} = 1, \]  \hfill (13)

Eq. (11) gives

\[ \delta V = \left[ (\delta v_1)^2 + (\delta v_2)^2 \right]^{1/2}. \]  \hfill (14)

This example shows that the square of the error in a sum is equal to the sum of the squares of the individual errors.

2. The unit cell of an orthorhombic crystal is a rectangular parallelepiped. The lattice parameters (lengths of the sides of the unit cell) have been found to be \( a \pm \delta a, b \pm \delta b \) and \( c \pm \delta c \). Then the volume of the unit cell is

\[ V = abc. \]  \hfill (15)

Since

\[ \frac{\partial V}{\partial a} = bc, \quad \frac{\partial V}{\partial b} = ac, \quad \frac{\partial V}{\partial c} = ab, \]  \hfill (16)

Eq. (11) gives

\[ \delta V = \left[ b^2 c^2 (\delta a)^2 + a^2 c^2 (\delta b)^2 + a^2 b^2 (\delta c)^2 \right]^{1/2}. \]  \hfill (17)

This result can be simplified by using Eq. (15), giving

\[ \frac{\delta V}{V} = \left[ \left( \frac{\delta a}{a} \right)^2 + \left( \frac{\delta b}{b} \right)^2 + \left( \frac{\delta c}{c} \right)^2 \right]^{1/2}. \]  \hfill (18)

This example shows two important points.
(i) The square of the fractional error in a product is equal to the sum of the squares of the individual fractional errors.

(ii) In many cases, as in this example (but not in the previous one), it is simpler to relate fractional errors to each other, rather than absolute errors.

The method of superposition of errors outlined here is a most important one, since it is used in nearly all experiments in which quantitative measurements are made. The quantity one is trying to determine is in many cases not directly measured, but is calculated from other, directly measured quantities.

5. Straight line fitting

In many cases, measurements are made of a quantity $y$ as a function of $x$, when a linear relationship

$$y = a + bx$$

is believed to exist between $y$ and $x$. The object is to determine $a$ and $b$ by finding the straight line that is the ‘best fit’ to the set of measured points. Suppose that $n$ values of $x$ are chosen $(x_1, x_2, \ldots, x_n)$, and the corresponding values of $y$, i.e. $(y_1, y_2, \ldots, y_n)$ are measured. We assume that $x_1, x_2, \ldots, x_n$ are accurately known, but $y_1, y_2, \ldots, y_n$ are subject to error. The problem is to find the line that is as near as possible to the points $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$. There are several methods for finding a line that satisfies this criterion to some extent. The best line is the one found by the method of least squares. In this method, we consider the sum of the squares of distances of the points from any given line, measured in the $y$-direction, and try to find the values of $a$ and $b$ that make this sum a minimum. The distance of the point $(x_1, y_1)$ from a line such as that given by Eq. (19) is

$$d_1 = \left| y_1 - a - bx_1 \right|,$$

for the point $(x_2, y_2)$, the distance is

$$d_2 = \left| y_2 - a - bx_2 \right|,$$

and so on. The sum $Q$ we are trying to minimise is
\[ Q = (y_1 - a - bx_1)^2 + (y_2 - a - bx_2)^2 + \ldots + (y_n - a - bx_n)^2. \]  

(22)

The conditions for \( Q \) to be a minimum are

\[ \frac{\partial Q}{\partial a} = 0 \quad \text{and} \quad \frac{\partial Q}{\partial b} = 0. \]  

(23)

From the first condition we get

\[ -2(y_1 - a - bx_1) - 2(y_2 - a - bx_2) - \ldots - 2(y_n - a - bx_n) = 0, \]  

(24)

which can be rewritten

\[ (y_1 + y_2 + \ldots + y_n) - an - b(x_1 + x_2 + \ldots + x_n) = 0. \]  

(25)

Since \( x_1, x_2, \ldots, x_n \) and \( y_1, y_2, \ldots, y_n \) are known, we can calculate the expressions in the brackets. For simplicity we put

\[ S_x = x_1 + x_2 + \ldots + x_n, \]  

(26)

\[ S_y = y_1 + y_2 + \ldots + y_n. \]  

(27)

Then

\[ an + bS_x = S_y. \]  

(28)

Similarly, from the second condition we have

\[ -2x_1(y_1 - a - bx_1) - 2x_2(y_2 - a - bx_2) - \ldots - 2x_n(y_n - a - bx_n) = 0 \]  

(29)

which gives

\[ aS_x + bS_{xx} = S_{xy}, \]  

(30)
where

\[ S_{xx} = x_1^2 + x_2^2 + \ldots + x_n^2, \]  
(31)

\[ S_{xy} = x_1y_1 + x_2y_2 + \ldots + x_ny_n. \]  
(32)

We can obtain \( a \) and \( b \) from Eqs (28) and (30):

\[ a = \frac{S_{xx}S_y - S_{xy}S_x}{nS_{xx} - S_x^2}, \]  
(33)

\[ b = \frac{nS_{xy} - S_xS_y}{nS_{xx} - S_x^2}. \]  
(34)

It is also important to estimate the error in \( a \) and \( b \). They are given by

\[ \delta a = \left[ \frac{QS_{xx}}{(n-2)(nS_{xx} - S_x^2)} \right]^{1/2}, \]  
(35)

\[ \delta b = \left[ \frac{nQ}{(n-2)(nS_{xx} - S_x^2)} \right]^{1/2}. \]  
(36)

6. **Average value of results with different errors**

Suppose a quantity \( x \) is measured independently \( n \) times, and the results are

\[ x_1 \pm \delta x_1, \ x_2 \pm \delta x_2, \ldots, \ x_n \pm \delta x_n. \]

In such cases, the arithmetic mean

\[ \langle x \rangle = \frac{1}{n} \sum_{i=1}^{n} x_i \]  
(37)

does not give the best estimate of the result. As the various measurements are not equally accurate, the result is more likely to be close to the more accurate measurements than the less accurate ones. It is therefore better to estimate the result using a **weighted mean**, in which we give **greater** weight to the values whose errors are **smaller**. The weighted mean is
\[
\langle x_w \rangle = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i},
\]

(38)

where \( w_1, w_2, \ldots, w_n \) are the weights assigned to \( x_1, x_2, \ldots, x_n \) respectively. It is usual to assume that the weights are inversely proportional to the errors:

\[
w_i = \frac{1}{(\hat{\delta} x_i)^2} \quad (i = 1, 2, \ldots, n).
\]

(39)

The error in \( \langle x_w \rangle \) can be calculated in two different ways.

1. The **external** error \( \hat{\delta} x_{E} \) is related to the scatter of the \( x_i \)-values about \( \langle x_w \rangle \):

\[
(\hat{\delta} x_{E})^2 = \frac{\sum_{i=1}^{n} x_i - \langle x_w \rangle}{(n-1)\sum_{i=1}^{n} \frac{1}{(\hat{\delta} x_i)^2}}.
\]

(40)

2. The **internal** error \( \hat{\delta} x_{I} \) is related to the individual errors \( \hat{\delta} x_i \). It can be derived by applying the superposition formula, Eq. (11), to Eq. (38):

\[
(\hat{\delta} x_{I})^2 = \left[ \sum_{i=1}^{n} \frac{\partial \langle x_w \rangle}{\partial x_i} \right] (\hat{\delta} x_i)^2 = \left[ \sum_{i=1}^{n} \frac{1}{(\hat{\delta} x_i)^2} \right]^{-1}.
\]

(41)

The results are consistent if \( \hat{\delta} x_{E} \) and \( \hat{\delta} x_{I} \) are of the same order of magnitude. (For example, if each measurement is thought to be very accurate but the different measurements differ from each other by large amounts, then something must be wrong. Conversely, it is rather an unlikely coincidence if the measurements are thought to be rather inaccurate but the different values are all nearly equal.)

We can define a consistency parameter, \( Z = \hat{\delta} x_{E} / \hat{\delta} x_{I} \), which should be of the order of 1 for the results to be consistent. From Eqs (40) and (41),
\[ Z^2 = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \langle x_i \rangle)^2. \]  

The best estimate of the error in \( \langle x_i \rangle \) is either the larger of \( \delta x_E \) and \( \delta x_I \), or \( \delta x = \left[ (\delta x_E)^2 + (\delta x_I)^2 \right]^{1/2} \).

7. Quoting the results and errors

In most experiments, the error itself is unlikely to be known very accurately (unless the result is based on a very large number of measurements of the same quantity). The error should in most cases only be quoted to one significant figure, except if that first figure is 1, then sometimes two significant figures may be given. The error can now be used to find the number of significant figures in the result, and the result should be rounded off accordingly. The general rule is that the result and error should be quoted to the same number of decimals. For example, a measured interatomic distance could be given as

- \( a = (0.427 \pm 0.003) \) nm, or as \( a = (0.43 \pm 0.02) \) nm, or as \( a = (0.427 \pm 0.013) \) nm, or as \( a = (0.427 \pm 0.010) \) nm, or as \( a = (0.42735 \pm 0.00007) \) nm, depending on the magnitude of the error. But the following examples are incorrect: \( a = (0.42735 \pm 0.003) \) nm (the last two decimals of the result are not significant), \( a = (0.43 \pm 0.002) \) nm (not enough significant figures in the result), \( a = (0.427 \pm 0.01) \) nm (which should be either 0.427 \pm 0.010 or 0.43 \pm 0.01), \( a = (0.427 \pm 0.00385) \) nm (the error should be rounded off to 0.004), and \( a = (0.42735 \pm 0.00385) \) nm (the error should be rounded off to 0.004 and the result to 0.427).

The result and error should always be quoted together, as in the first four examples above. The error may sometimes also be quoted as a percentage, which is a convenient way of comparing the accuracy of results obtained by different methods.

J P Jakubovics
Department of Materials 11 July 1995
Appendix C: External MS Part II Briefing Notes

These notes are to give you some guidance only, on making arrangements for external Part II projects. They are not exhaustive and no two cases are quite the same. There are many pitfalls to making such arrangements and whilst it is your own responsibility to organise external projects yourselves, it is important that you keep the Part II Organiser (currently Prof Keyna O’Reilly) informed, such that she can offer guidance, can ensure that the arrangements (host institution, project) are appropriate for an Oxford Part II, and can help to protect your interests if necessary.

Responsibility for Organising External Projects
- Arrangements entirely the student's responsibility.
- We can of course offer some guidance and help.
- Must keep the Part II Project Organiser (me) in the loop, i.e. informed of all developments.
- Although external projects are allowed, we do not necessarily encourage them, and particularly not for all students.
- Attractive for CV, but there are risks involved in such projects:
  - we may not know the external supervisor or how well respected they are,
  - we cannot guarantee that an external supervisor fully understands what is required of the Part II,
  - we cannot keep a constant eye on the progress of the student or their project, etc.
- Given those risks, we will only allow a student to carry out their project externally if
  - we feel that the external supervisor is appropriately senior,
  - the project is appropriate for the length and standard of Part II,
  - that the college tutor, the Part II Organiser and the appointed internal Oxford academic supervisor feel that the student is academically able and sufficiently self-motivated and strong to work well away from Oxford.

Project Length
- The Part II year is longer than usual.
- At least 36 weeks long, over "extended" terms (longer than the normal 8 week terms).
- Mid-September to the end of June (The thesis is handed in on Monday of 7th week of Trinity Term).
- Whole of Trinity term in Oxford, and so must return to Oxford shortly after Easter, in time for the Part II talks.

Assessment
- The thesis is key to the assessment of Part II.
- The external institution is not required to provide any formal assessment of the project, but all supervisors are requested at the end of the project to make some comments on the way the student has dealt with the project, if any difficulties arose, how much help they had etc.
- After submitting the thesis you will be subject to a viva voce exam in week 9 or 10 of Trinity Term.
- In addition to the thesis all Part II students are required to give a presentation (early Trinity Term), but the presentation does not count towards the exam mark.

Lecture Courses and Training
- The Part II is a research project and you are not required by us to sit any lecture courses.
- We do encourage Part II students to attend some lectures that might be of use to their projects or be of general interest.
- In Oxford these often take the form of postgraduate lecture courses or departmental seminars/colloquia for instance.
• Part II students carrying out their projects in Oxford may be required to attend lectures associated with training for the use of certain experimental techniques, e.g. electron microscopy, or safety lectures.
• Essentially then you would be at the host institution there to do research, but it is likely that host institutions will take a similar approach to us and you should attend any courses necessary, as required by the host institution, for training on instrumentation and safety etc.
• You will need to check with the host institution how you will receive training etc

Publication
• No requirement to produce published works from your Part II project
  o although some research publications are produced after projects have been completed,
  o examiners may well consider if the work is publishable.

Confidentiality and Intellectual Property
• Host institution will be concerned with issues of confidentiality and IP, e.g.
  o project may be part of a large research programme that has restrictions on what information can be released,
  o or you may be working as part of a team that invents something that could be of commercial benefit to the host institution.
• Better to avoid such projects if possible
  o but if these issues are apparent then a research contract will need to be drawn up between the host institution and the University of Oxford which will establish what measures need to be taken to preserve confidentiality and to assign the ownership of any IP that might be developed during your project, and to protect your interests in ensuring that you are not prevented from fulfilling the requirements of your degree.
• Such negotiations can be very protracted and it is best that we know if this is likely to be an issue at the earliest possible stage.
• Do NOT sign any such agreements the host institution before getting advice from myself or Adrian Taylor.

Oxford Academic Supervisor
• Likely that the time spent abroad would be for practical work and reviewing the literature, whilst the bulk of the thesis will be written once the student has returned.
• As a result, and to ensure that the student’s progress is being monitored continually, we insist that an internal (Oxford based) supervisor is appointed to the project.
• The internal supervisor should be knowledgeable in the field in which the student will be working.
• It is up to the student to find an internal supervisor that is willing to oversee their progress remotely, and to give guidance during the preparation of the thesis (of course the student should keep in contact with the external supervisor during this period).
• We will also ask the internal supervisor to comment on the suitability of the project in the first place.
• If an internal supervisor cannot be found, the project will not be approved.

Project Management
• All Part IIs required to complete a series of project management forms during the project.
• To encourage you to think periodically about your objectives and progress.
• Discuss the completion of these forms with both your external and internal supervisors.
• If you are away from Oxford, you will miss the Project Management Workshop given to Part II students by an external professional project manager,
**Costs**

- Any costs associated with carrying out the project externally, e.g.
  - travel,
  - maintenance,
  - health insurance,
  - course fees required by the host institution must be met by the student.
- We can offer some assistance in applying for funding to contribute towards the costs.
- College will still require fees for the full year.
- Your College may be able to help financially, but you will have to investigate this with your particular College.
- It is quite possible that you will meet students from other Oxford departments at the same host institution. They may be there under a specific scheme and may be receiving funding. You will not. Princeton example.
- MIT do not currently charge a fee – if your potential supervisor there tells you they do, ask them to speak with Prof Linn Hobbs.

Oxford has made the decision that Home/EU students on optional years abroad, such as our Materials Part II students at MIT, should pay the same year abroad rate as Oxford students on a compulsory year abroad.

The relevant fee information is at [http://www.ox.ac.uk/students/fees-funding/fees/abroad](http://www.ox.ac.uk/students/fees-funding/fees/abroad). For Home/EU students who started their courses in 2012-13 or later, the year abroad fee will be £1350 in 2015-16.

You will be able to apply for and receive a loan for the year abroad fee from the SLC.

**SEPT 2015**

**A Final Word**

- By the end of MT you should be aiming to have
  - identified a host institution,
  - identified a supervisor at the host institution,
  - identified an internal Oxford academic supervisor,
  - have agreed an outline project description.

**Checklist**

- Identify host institution.
- Identify supervisor at host institution.
- Inform the Part II Organiser of your plans (she will seek the opinion of your College tutor on your suitability for an external project).
- Approach host institution. Make the host supervisor aware of the MS Part II Course Handbook, so that s/he can familiarise themselves with the course requirements.
- Obtain one or more project descriptions (one side of A4 for each project should be sufficient).
- Identify an internal Oxford academic supervisor.
- Discuss project descriptions with Part II Organiser, College Tutor and Oxford supervisor.
- Put your proposed host institution supervisor in contact with the Part II Organiser to discuss any confidentiality/IP issues.
- Identify personal costs for the project, and apply for supporting funds.
- Alert the Director of Studies that a Memorandum of Understanding (MoU) will be required between Oxford and the host institution.

**Later in the process**

- There will be another checklist dealing with such items as flights, health insurance etc.
- You will have to take out appropriate travel insurance and health insurance, including travel insurance cover through the Oxford University block policy.
• In order to obtain the University Insurance you will need to do a risk assessment for your project. Adrian Taylor will provide some initial guidance on this, but it will be your responsibility.
• You may need to take out additional insurance to that provided via the University if you intend to take holiday while away or take part in potentially dangerous leisure activities.
• You will need to take out additional health insurance – the insurance via the University only covers you in case of emergency.
• Adrian Taylor will check with your host institution as to their insurance cover for you while you are working there. This is known as their liability insurance. If we have concerns over the adequacy of this cover and are unable to arrange appropriate independent cover it may be necessary to cancel your external project.

(Part II Projects Organiser), January 2016