

University of Sydney
School of Physics

Senior Experimental Physics Handbook 2007

These notes are for students enrolled in any of the following units of study. The credit point number indicates the number of credit points allocated to the Physics lab component of the unit:

Semester 1

PHYS 3040, 3940 Electromagnetism & Lab (4 credit points)

PHYS 3050, 3950 Nanoscience/Optics & Lab (2 credit points)

PHYS 3051, 3951 Thermodynamics/Biol. Physics & Lab (2 credit points)

PHYS 3052, 3952 Nanoscience/Thermodynamics & Lab (2 credit points)

PHYS 3053, 3953 Thermodynamics/Optics & Lab (2 credit points)

Semester 2

PHYS 3060, 3960 Quantum Mechanics & Lab (4 credit points)

PHYS 3070, 3970 Plasma Physics/Cond. Matter & Lab (2 credit points)

PHYS 3071, 3971 High Energy/Astrophysics & Lab (2 credit points)

PHYS 3072, 3972 Plasma Physics/Astrophysics & Lab (2 credit points)

PHYS 3073, 3973 Plasma Physics/High Energy & Lab (2 credit points)

PHYS 3074, 3974 High Energy/Cond. Matter & Lab (2 credit points)

PHYS 3075, 3975 Cond. Matter/Astrophysics & Lab (2 credit points)

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1 ORGANISATION

1.1 The laboratory

The main laboratory is on the ground floor of the Physics Wing (Room 254). In the vestibule outside the laboratory and just inside the laboratory there are notice boards. Watch these notice boards and free standing notice boards in the laboratory. Inside the laboratory there is a cupboard with pigeonholes used for housing your logbooks.

1.2 Laboratory opening times

The laboratory is open Monday and Tuesday afternoons from 2 to 6 pm. Students are allowed access to the laboratory at other times, to gain access to the computers for example, provided staff are present.

1.3 The Experiments

The experiments in the Senior Laboratory are listed below.

Electronics and Signal Processing

2. Computer Interfacing to Experiment
3. Fourier analysis
4. Signal recovery
5. Noise

Electromagnetism

6. Transmission lines
7. Wave propagation
8. Microwaves
10. RF breakdown of gases

Diagnostic Probes and Techniques

11. Scanning tunnelling microscope
12. Langmuir probes
13. X-ray diffraction
14. Nuclear magnetic resonance
15. Electron spin resonance

Atomic and Nuclear

16. Optical pumping
17. X-rays
18. Mössbauer effect
19. Cosmic radiation
20. Beta decay
21. Alpha particles
22. Gamma radiation
23. Nuclear lifetimes

Optics

24. Michelson interferometer
25. Holography
26. Reflection characteristics
27. Fourier Optics
28. Interference spectroscopy

New Experiments

29. Galactic Dynamics
30. Thin-film deposition

These experiments are self-paced, so you should move onto the next experiment ONLY after completing the current experiment. At the fastest possible pace each experiment may take approximately 7-8 hours to complete satisfactorily. This corresponds to two laboratory sessions. However, you should not sacrifice quality for quantity since this will be reflected in your understanding of the physics and your grades.

Note that as a general rule - students work individually.

1.4 Booking an experiment

Experiment bookings should be made through the web on:

www.physics.usyd.edu.au/lab3booking

Students will be asked to register (on the web) then book an experiment in the first week of semester. Remember that most labs need two lab sessions. The computer based booking system will indicate this. The system will enable you to book experiments a fortnight in advance only, and will keep track on experiments that you have already done. The number of experiments you can book will be determined by the number of credit points of lab that you are doing i.e. 8 and 6 credit points can book 2 experiments, while 4 and 2 credit points can book 1 experiment. Each experiment is considered to take 2 lab sessions.

The last week (or two) in each semester is set aside for students to present a short talk on one of the experiments they have completed during the semester.

1.5 Number of experiments, reports and talks to be done

Look at the front cover of these notes and determine the TOTAL number of laboratory credit points that you are doing this semester. The total should be 2, 4, 6, or 8 credit points. This will determine the number of experiments that you should complete, as well as reports and talks. A summary of the number of the three tasks is given below:

Credit points	2	4	6	8
Experiments	3	5	8	10
Reports	1	2	3	4
Talks	0	1	1	2

Once you have booked into an experiment then you must complete it in two consecutive lab periods. The large number of students does not allow an experiment to remain free for you to come back to it another time. **Only those students taking 6 or 8 credit points of lab in the semester will be allowed to book for consecutive Monday and Tuesday lab sessions. The 2 and 4 credit point students may book for EITHER Mondays or Tuesdays.**

1.6 Laboratory staff

Laboratory coordinator	Dr. Reza Hashemi-Nezhad (for first semester) Dr. Joe Khachan (for second semester) Room 354 (Reza) reza@physics.usyd.edu.au Room 363 (Joe) J.Khachan@physics.usyd.edu.au
Senior Technical officer	Mr Marek Dolleiser
Tutors	Dr. Nicholas Ekins-Daukes Dr. Ian Falconer Prof. Richard Hunstead Assoc. Prof. Brian James Dr. Lucyna Kedziora-Chudczer Dr. Alex Samarian Dr. Richard Tarrant Dr. Murray Winn

Tutors specialise in groups of experiments, but should be able to provide some assistance with all experiments. Not all tutors will be available in the laboratory all

the time. It will often be possible for you to contact a particular tutor when they are not in the laboratory and Marek will help you in this regard. Problems may also be overcome by talking to other tutors or fellow students.

1.7 Schedule for 2007

First semester

Week 1 (5 Mar) Compulsory registration and introduction to the Senior laboratory 2.15 pm, Monday 5 March and Tuesday 6 March, in the laboratory

Week 2 (12 Mar) Lab session

Week 3 (19 Mar) Lab session

Week 4 (26 Mar) Lab session

Week 5 (2 Apr) Lab session

Easter break

Week 6 (16 Apr) Lab session

Week 7 (23 Apr) Lab session.

Week 8 (30 Apr) Lab session.

Week 9 (7 May) Lab session

Week 10 (14 May) Lab session

Week 11 (21 May) Lab session

Week 12 (28 May) **Talks**

Week 13 (4 June) **Talks**

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Second semester

Week 1 (23 July) Compulsory registration and introduction to the Senior laboratory 2.15 pm, Monday 23 July and Tuesday 24 July, in the laboratory

Week 2 (30 July) Lab session

Week 3 (6 Aug) Lab session

Week 4 (13 Aug) Lab session

Week 5 (20 Aug) Lab session

Week 6 (27 Aug) Lab session

Week 7 (3 Sep) Lab session

Week 8 (10 Sep) Lab session

Week 9 (17 Sep) Lab session

Mid-semester break

Week 10 (1 Oct) Lab session.

Week 11 (8 Oct) Lab session

Week 12 (15 Oct) **Talks**

Week 13 (22 Oct) **Talks**

1.8 Schedule for reports

Note that a penalty may be imposed for late submission of reports. While you will be required to submit reports on some of the experiments that you do, **logbook records must be kept for all experiments.**

The reports should be handed in your laboratory class in a box labeled **Reports**. The submission dates below coincide with lab days so you can hand them in on the Monday or the Tuesday.

The deadlines for submission of reports are:

First semester

Deadline	2 Apr	23 Apr	7 May	22 May
Credit points				
2				*
4		*		*
6		*	*	*
8	*	*	*	*

* indicates that a report is to be handed in during a lab period starting with the week indicated by the dates.

Second semester

Deadline	20 Aug	3 Sep	17 Sep	8 Oct
Credit points				
2				*
4		*		*
6		*	*	*
8	*	*	*	*

1.9 Recording of Experiments - Logbooks

Students are expected to record their experiments in a University supplied logbook as each experiment is carried out. This is the written record of the experiment involved. Students should carefully read the section “Guidelines for Recording Experimental Work,” in the supplementary notes, to see what is expected to be included in a logbook.

Depending upon which unit of study you are taking, you will be required to write up (from the material already in the logbook) reports on some of the experiments you do (see section 2). The section of the supplementary notes titled “Report Writing” should be followed in preparing these reports. **But in summary, a report should be similar to the format of a scientific paper.** An example of this will be posted on notice boards in the lab.

The fact that a report is required for an experiment does not mean that the logbook record should be in any way inferior. The length of all reports should be kept as short as possible consistent with their purpose. **Excluding graphs and diagrams the reports should be about 5 pages for the normal experiments. But this number is flexible. If you find that you need to go to 10 pages, then that is okay. Do not go to 10 pages simply to pad out the length of your report in the hope of getting more marks. In that case you will find the opposite will happen.**

There are computers in the laboratory freely available for data analysis and report preparation.

The following procedures should be followed with regard to logbooks and reports:

- You **cannot** take your logbook out of the laboratory. It should remain in the pigeonhole allotted to you when you are out of the laboratory. **Marks may be deducted if a logbook is found missing from a pigeon hole.** The only time that you will be permitted to take the logbook out of the laboratory is during the week in which the report is due. For example, you can take it home on the Monday (or Tuesday) of your lab day and return it with your report the following Monday (or Tuesday) with your report.
- When the logbook record of an experiment is completed (this must be done during the time allocated for the experiment) **you should ensure that it is signed and dated by your tutor or, if not available at the time, by any other tutor or technician.** This signature will serve to validate the work that has been carried out in the allotted time. No marks will be awarded to unsigned experiments.
- Marks **will be** deducted for any pages torn out of your logbook. Similarly marks will be deducted if it is found that you have altered your logbook outside of laboratory hours. No work will be marked that has been added after a tutor's final signature.
- Your logbook must contain an index. When an experiment is marked enter the mark in this index. This will make it easier for tutors to check which experiments need marking.
- Reports must have a filled-in coversheet as their first page. Coversheets will be available in the laboratory, and on the web.
- Reports will be due on your normal laboratory day. Simply place the reports in the specially marked box (in the lab) for report marking.

1.10 Talks

Towards the end of each semester students will be asked to nominate an experiment for a 10 minute minitalk to be presented by the student to all the other students and the tutors. It is hoped in these talks that students will be able to summarise not only what they have done but also the physical significance of their results. Marks will be awarded on this bases as well as the style of presentation.

You are encouraged to use these talks as an opportunity to practice presentation skills. Use of *Powerpoint*, or equivalent presentation software is encouraged.

2 ASSESSMENT

The assessment of the unit will be through marks awarded to the logbook write-ups and the reports. The logbook write-ups will be marked as either **Satisfactory or Incomplete**. If you have been given an **incomplete** then suggested further work will be needed to make it satisfactory. Once a logbook has been given a satisfactory then it will receive 5 marks. In the exceptional circumstances where a student has done work that is "above and beyond" what is required in the lab, then an additional **bonus mark** will be given. Keep in mind that this bonus mark will only go to truly

outstanding work. The reports will be graded out of 10. The maximum unscaled marks allotted to the various components of the course are as follows:

Component	Marks
Logbook write-ups	5 per experiment (plus 1 bonus mark)
Reports	10 per experiment
Talks	10

This means that the maximum achievable marks for:

2 CP is 3 logbook write-ups + 1 reports + 0 talk = 28 Marks

4 CP is 5 logbook write-ups + 2 reports + 1 talk = 60 Marks

6 CP is 8 logbook write-ups + 3 reports + 1 talk = 88 Marks

8 CP is 10 logbook write-ups + 4 reports + 2 talk = 120 Marks

Final marks will be incorporated as part of the total marks for the unit of study. For example, the lab component PHYS 3940 is 4 credit points out of 6. As a result, the lab mark is worth $2/3$ of the total mark for the unit of study. If the total number of lab credit points comes from different units of study, then the lab mark will be divided in proportion to the weighting of the lab for the unit of study. For example, say 6 credit points is composed of 4 credit points from PHYS 3940 and 2 credit points from PHYS 3951. Consequently, $2/3$ of the lab mark will go to PHYS 3940 and $1/3$ to PHYS 3951.

Guidelines for keeping logbooks and writing reports are given in “GUIDELINES FOR RECORDING EXPERIMENTAL WORK” and “REPORT WRITING” sections, respectively, of the supplementary notes (available on the web). Logbooks and reports will be assessed with reference to these guidelines and especially with the following marking scheme.

3 SENIOR LABORATORY MARKING SCHEME FOR LOGBOOKS AND REPORT

Report Marking Scheme

- 6 or 7 out of 10 where **most** of the following criteria are met
- 8 - 10 out of 10 where **all** of the following criteria are met
 - Abstract given.
 - Document is well presented with an easy to follow structure, e.g. Title, Introduction, Method, Experimental set-up, Results and Discussion, Conclusions, References.
 - Clear indication of a deep knowledge of the topic.
 - Diagrams well presented with Figure numbers and clear and informative captions.
 - Graphs have clearly labeled axes.
 - Analysis correct, and error analysis is sensible.
 - The whole report is self-contained and does not require reference to the laboratory notes.

- The writing is clear and easy to follow.
- A mark of 5 will be given if:
 - the document just reports on what was done without a clear understanding of the issues.
 - most of the points above are not followed.
- A mark less than 5 will be given if:
 - the document is patchy, incomplete, disorganized, hard to follow.
 - includes extraneous and irrelevant information to impress or to hide the lack of understanding of the experiment.

Logbook Marking Criteria

- **Satisfactory** (5 marks) where **most** of the following criteria are met.
- **Satisfactory + bonus mark** (6 marks) where **all** of the following criteria are met.
 - It is clear that the logbook was worked upon in the lab and not amended outside of lab hours.
 - A deep knowledge of the topic is evident.
 - Logbook easy to follow.
 - Logbook is a self-contained detailed record of the experiment so that anyone else can easily follow what was done.
 - Well organized with headings e.g. Date, page numbers, aim, headings for the different sections, results and analysis, discussion of the results, conclusions.
 - Practical details are included that could not otherwise be obtained without doing the experiment.
 - Sensible error analysis.
 - Correct numerical analysis of the results.
 - References (if any) are given.
- An **incomplete** will be given if many of the above criteria are not met, half or less of the experiment has been completed, and/or a very poor and patchy record is kept e.g. some numbers given with an occasional statement. In these cases, tutors will suggest further work in order to achieve a satisfactory.

Dishonesty

Scientific reporting of results is based on trust. **You could face immediate failure or severe penalties** if your logbooks or reports include any of the following:

- used other peoples results and claimed they were your own.
- made up the data.
- forged a demonstrators signatures.
- copied another persons logbook or report.