Introduction

This is the Student Handbook for the UCL MSc/Postgraduate Diploma/Postgraduate Certificate Programme in Space Science and Engineering, which has two Pathways:

- Space Technology
- Space Science

The Programme runs over a full calendar year. This Handbook is intended to give students joining the Programme the basic information they will need about it, information about the facilities and the host departments, the main procedures to be followed, and references to further sources of information.

The MSc/Postgraduate Diploma/Postgraduate Certificate Programme in Space Science and Engineering is run jointly by the Department of Space and Climate Physics and the Department of Electronic and Electrical Engineering.

The Department of Space and Climate Physics is the Admitting Department for the Programme.

The following abbreviations are used in this Handbook:

- SSE (MSc/Postgraduate Diploma/Postgraduate Certificate) Space Science and Engineering (Programme code TMSSPSAENG10)
- ST (Pathway) Space Technology (Route code TMSSPSSTEC12)
- SS (Pathway) Space Science (Route code TMSSPSSING11)
- S&CP Department of Space and Climate Physics
- E&EE Department of Electronic and Electrical Engineering

UCL’s Academic Regulations for Students apply to this MSc /Postgraduate Diploma/Postgraduate Certificate Programme.

The information in this Handbook is believed to be correct at the time of printing, but may be subject to change during the year. Further information can be obtained from the Programmes Website http://www.ucl.ac.uk/mssl/taught-programme/msc-space-sci-eng. Students will be informed of any changes to this Handbook, or any further information regarding the Programme, by email or by notices in the relevant department (see below for locations).

Graziella Branduardi-Raymont, MSc (Space) Programme Tutor
Programme Information

Aims and Objectives

The Programme aims to enable successful students to put the skills and knowledge gained to good use, in either employment or in further study such as PhD research.

The ST Pathway is focussed on the application of space technology in industrial settings, and therefore has this main objective:

• To provide students with a sound knowledge of the underlying principles which form a thorough basis for careers in space technology, satellite communications and related fields.

The SS Pathway is focussed on scientific research applications of space technology, and has the objective:

• To provide students with a sound knowledge of the underlying principles which form a thorough basis for careers in space science and related fields.

The two Pathways share a number of common aims and objectives:

• To enable students to develop insights into the techniques used in current space missions.

• To allow students to have an in-depth experience of a particular specialised area, through project work, as a member of a research team.

• To develop students’ professional skills which are necessary to play a meaningful role in industrial or academic life and satisfy the need, both nationally and internationally, for well-qualified postgraduates who will be able to respond to the challenges that arise from future developments.

• To give students the experience of teamwork, to develop students’ report-writing and presentation skills, and to train students to work to deadlines.

The two Pathways share a great deal, but there are important differences, especially in the course options structure. Refer to *Programme Details* below.
Programme Details

Both ST and SS Pathways of the MSc/Diploma/Certificate Programme in ‘Space Science and Engineering’ comprise taught Core and Advanced modules, the Individual Project and the Group Project.

The two Pathways differ in one of their Core modules and in the options available for the Advanced modules, so these notes should be studied carefully.

Course Codes

Lecture modules and the projects that make up the MSc/Diploma/Certificate Programme have UCL codes (SPCE…., ELEC…., etc.) which you will need for accessing information on them via PORTICO (see later). We also have historical Departmental codes (beginning with the letters SS or ST) for some of the modules, but they are not used in this Handbook.

Structure of the MSc/Diploma/Certificate Programme

Students gain ‘credits’ when they complete each one of the components of the MSc/Diploma/Certificate Programme (taught Core and Advanced modules, the Individual Project and the Group Project); the total number of credits required to obtain the MSc degree is 180, while a Postgraduate Diploma and a Certificate require 120 and 60 credits, respectively. The structure of the MSc/Diploma/Certificate Programme is summarised in the table on page 5.

The overall average MSc/Diploma/Certificate mark is the average of the marks obtained in all components (taught Core and Advanced modules, the Individual Project and the Group Project), weighted according to the number of credits attributed to each. To obtain an award, students must obtain an overall average mark of at least 50%, and a mark of at least 50% in all individual components, i.e. each Core and Advanced module, the Individual Project and the Group Project. If these criteria are met, the Examination Board will normally condone a failure to achieve the MSc/Diploma/Certificate pass mark of 50% in one of the taught modules, provided that the mark for that module is at least 40%.

Otherwise, failure of any taught module examination requires a re-sit of that component to be completed successfully in a subsequent year in order to obtain the MSc/Diploma/Certificate. Failure in the Individual or Group Project component requires a re-submission in a subsequent year.

In order to gain an award of MSc with Distinction, a student must obtain an overall average mark of at least 70%, and obtain a mark of at least 70% for the Individual Project and a mark of at least 50% for each other component (all marks being based on first attempts).

An award of MSc with Merit will be made when the overall average mark is at least 60%, the mark for the Individual Project is at least 60%, there are no marks below 50% and no condoned marks (all marks being based on first attempts).

The following diagram summarises the mark classification adopted in all taught and project components of the Programme:

| 0 - 39% | Fail |
| 40 - 49% | Condonable Fail |
| 50 - 59% | Pass |
| 60 - 69% | Merit |
| 70 - 100% | Distinction |

At the discretion of the Examination Board, considering all students together on both SS and ST Pathways of the Programme, prizes are sometimes awarded for Best Individual Project and Best Overall Achievement.

The main formal meeting of the Examination Board takes place on the last day of the Programme and it is at this meeting that the MSc results are decided - not before!
You will be invited to a Progress Meeting with the Programme Team early in the second term to review your performance in the first term, to give a short presentation on work carried out and future plans for your Individual Project, and to discuss your Initial Project Report.

*It is important that you heed the advice offered during this meeting, otherwise you may not be successful later in the year.*

### Postgraduate Diploma and Postgraduate Certificate Exit Points

MSc/Diploma/Certificate Programme elements are operated concurrently, with the Postgraduate Diploma and Postgraduate Certificate as exit points for students who do not attain the 180 credits required for an MSc award. As such, Postgraduate Diploma and Certificate can be offered as an alternative to re-sitting failed modules in the attempt to gain enough credits for an MSc award.

The **Diploma** is obtained by gaining 120 credits: these must be achieved by passing all seven taught modules and the Group Project.

The **Certificate** is obtained by gaining 60 credits: these are achieved by passing four taught modules, of which at least one has to be a Core Module.

In order to be eligible for a Postgraduate Diploma/Certificate award, a student must complete all required components of the Programme satisfactorily. The overall mark for the Diploma/Certificate is the average of the marks for all these components, weighted according to the number of credits attributed to each.

If a student fails to achieve the marks required for a Postgraduate Diploma/Certificate (i.e. at least 50% for each component) he/she can re-sit the relevant exams for the Diploma/Certificate in a subsequent year.

### Learning Agreements

Some overseas students are required to submit ‘Learning Agreements’ forms for College approval. Please note that the forms should be handed in to the Programme Team by 10th November at the latest.

### Programme Timetable/Calendar

The Programme Timetable/Calendar is distributed at the introductory meeting (a draft version), and is published on the Programme Moodle Website; the Moodle version will always be kept up-to-date, so students should use it in preference to other versions and check it often for updates.

### Personal Tutor

The Individual Project supervisor acts as Personal Tutor, who gets to know the student as an individual, keeps an eye on their overall academic progress and is concerned for their general welfare. During the period before the appointment of the Project supervisor the Programme Tutor acts as Personal Tutor to the students.

### Format of Modules

There are two different formats for the lecture modules and their exams.

- **‘SHORT FAT’ MODULES** *(SPCEGC03, ELECGT02, ELECGC01, ELECGC16)*
  
  These modules are ‘short and fat’, i.e. running with many lectures condensed into a short period. All are run with 6 lecture-hours per day over 4 or 5 consecutive days, followed by tutorial(s) and an exam in the following few weeks. The Core Modules that are ‘short and fat’ are SPCEGC03 and ELECGT02; the Advanced Modules are ELECGC01 and ELECGC16.

- **‘LONG THIN’ MODULES** *(all others)*
  
  These modules are ‘long and thin’, i.e. running with a few lectures per week over a whole term, with an exam in the summer.
### MSc/Postgraduate Diploma/Certificate Programme in 'Space Science and Engineering'

#### Core Modules - Term 1

<table>
<thead>
<tr>
<th>Selection</th>
<th>UCL code</th>
<th>credits</th>
<th>Title</th>
<th>Teaching Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Science (SS) pathway</td>
<td></td>
<td>45</td>
<td>Take all three CORE courses</td>
<td></td>
</tr>
<tr>
<td>CORE</td>
<td>SPCEGC01</td>
<td>15</td>
<td>Space Science, Environment and Satellite Missions</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>CORE</td>
<td>SPCEGC02</td>
<td>15</td>
<td>Space Systems Engineering</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>CORE</td>
<td>SPCEGC03</td>
<td>15</td>
<td>Space Data Systems and Processing</td>
<td>'Short, fat'</td>
</tr>
</tbody>
</table>

#### Advanced Modules - Term 2 (see exceptions under Notes)

<table>
<thead>
<tr>
<th>Selection</th>
<th>UCL code</th>
<th>credits</th>
<th>Title</th>
<th>Teaching Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Science (SS) pathway</td>
<td></td>
<td>60</td>
<td>Take COMpulsory module, and three OPTIONS</td>
<td></td>
</tr>
<tr>
<td>COMP</td>
<td>SPCEG001</td>
<td>15</td>
<td>Space Instrumentation and Applications</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>OPTION</td>
<td>SPCEG011</td>
<td>15</td>
<td>Planetary Atmospheres</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>OPTION</td>
<td>SPCEG012</td>
<td>15</td>
<td>Solar Physics</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>OPTION</td>
<td>SPCEG013</td>
<td>15</td>
<td>High Energy Astrophysics</td>
<td>In Term 1</td>
</tr>
<tr>
<td>OPTION</td>
<td>SPCEG002</td>
<td>15</td>
<td>Space Plasma and Magnetospheric Physics</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>OPTION</td>
<td>GEOG141</td>
<td>15</td>
<td>Principles and Practice of Remote Sensing</td>
<td>In Term 1</td>
</tr>
<tr>
<td>OPTION</td>
<td>GEOG142</td>
<td>15</td>
<td>Global Monitoring and Security</td>
<td>Geography</td>
</tr>
</tbody>
</table>

| Space Technology (ST) pathway | | | Take four OPTIONal modules, at least one each from group A (Systems Modules) and group B (Applications Modules) | |

**Exit Point:** Postgraduate Certificate, if passed four taught modules, of which at least one must be a Core Module (i.e. 60 credits total)

<table>
<thead>
<tr>
<th>Selection</th>
<th>UCL code</th>
<th>credits</th>
<th>Title</th>
<th>Teaching Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: OPTION</td>
<td>SPCEG007</td>
<td>15</td>
<td>Space-based Communication Systems</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>A: OPTION</td>
<td>SPCEG008</td>
<td>15</td>
<td>Spacecraft Design - Electronic Sub-systems</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>A: OPTION</td>
<td>SPCEG009</td>
<td>15</td>
<td>Mechanical Design of Spacecraft</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>A: OPTION</td>
<td>ELECG001</td>
<td>15</td>
<td>Antennas and Propagation</td>
<td>'Short, fat'</td>
</tr>
<tr>
<td>A: OPTION</td>
<td>ELECG016</td>
<td>15</td>
<td>Radar Systems</td>
<td>'Short, fat'</td>
</tr>
<tr>
<td>B: OPTION</td>
<td>SPCEG003</td>
<td>15</td>
<td>Space Data Systems and Processing</td>
<td>'Short, fat'</td>
</tr>
<tr>
<td>B: OPTION</td>
<td>SPCEG001</td>
<td>15</td>
<td>Space Instrumentation and Applications</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>B: OPTION</td>
<td>SPCEG002</td>
<td>15</td>
<td>Space Plasma and Magnetospheric Physics</td>
<td>S&amp;CP</td>
</tr>
<tr>
<td>B: OPTION</td>
<td>GEOG141</td>
<td>15</td>
<td>Principles and Practice of Remote Sensing</td>
<td>In Term 1</td>
</tr>
<tr>
<td>B: OPTION</td>
<td>GEOG142</td>
<td>15</td>
<td>Global Monitoring and Security</td>
<td>Geography</td>
</tr>
</tbody>
</table>

### Problem-based learning and career training: Group Project

<table>
<thead>
<tr>
<th>credits</th>
<th>15 total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPCEG089</td>
<td>15</td>
</tr>
</tbody>
</table>

**Exit Point:** Postgraduate Diploma, if passed all seven taught modules and the Group Project (i.e. 120 credits total)

### Research Programme: Individual Project

<table>
<thead>
<tr>
<th>credits</th>
<th>60 total</th>
</tr>
</thead>
</table>

**No difference between SS and ST pathways, except choice of Individual Project subject**

| SPCEG099 | 15 | Interim Report (over Terms 1 and 2) |
|----------|----------|
| 45 | Final Report (Term 3) |

**MSc award if successful in all four components (described in the four boxes, i.e. 180 credits total)**

S&CP: Space and Climate Physics Department

E&EE: Electronic & Electrical Engineering Department
Core Modules

During the First Term (September - December) students attend the following Core Modules. Lecture dates and times are given in the Programme Timetable/Calendar. Examinations for Core Modules SPCEGC03 and ELECGT02 normally take place during the First Term or early in the Second Term, as shown in the Programme Timetable/Calendar. These modules aim to give all students, with their diverse academic backgrounds, a thorough, basic understanding of the major aspects of the field, and they form an essential background to the Advanced Modules. They also provide an introduction to the UK examination style for non-UK students.

ST Core Modules

- SPCEGC01  Space Science, Environment and Satellite Missions – Dr S. Matthews, Prof. A. Coates, Mr M. Whyndham
- SPCEGC02  Space Systems Engineering – Dr I. Hepburn, Mr M. Whyndham
- ELECGT02  Communication Systems Modelling – Dr K. K. Wong, Dr Y. Andreopoulos, Dr R. Clegg

During the initial weeks of the Programme it will be very useful for students to read up on basic electromagnetism (up to Maxwell’s equations) & basic electronics (including AC circuits and transmission lines). This is particularly important for those with a physics-based degree rather than an electronic engineering degree. Students can ask the Tutors for suggested textbook chapters to use for revision.

Please note that ELECGT02 requires a strong background in communication techniques that e.g. Physics graduates do not normally possess, and this has hampered the performance of some past students in this module. For this reason students lacking the appropriate background knowledge are permitted to substitute ELECGT02 with SPCEGC03 as their Core Module.

SS Core Modules

- SPCEGC01  Space Science, Environment and Satellite Missions – Dr S. Matthews, Prof. A. Coates, Mr M. Whyndham
- SPCEGC02  Space Systems Engineering – Dr I. Hepburn, Mr M. Whyndham
- SPCEGC03  Space Data Systems and Processing – Prof. L. Harra, Dr P. Groves, Prof. M. Ziebart, Prof. A. Smith, Dr I. Ferreras

Advanced Modules

The details here are different for the two Pathways, so please read carefully. You are welcome to attend more than four of the Advanced Modules, but you can only be examined in four of them.

You must make a decision in early October on which Advanced Module exams to take for the MSc/Diploma/Certificate, and you will have to enter your exam choices into the Registry PORTICO database – the Programme Team will contact you about this in early October.

Please note that some optional Advanced Modules are taught in the First Term (GEOGG141 – Principles and Practice of Remote Sensing, SPCEG013 – High Energy Astrophysics, and SPCEGC03 – Space Data Systems and Processing, this last being an option for the ST Pathway), with exams in the First or early in the Second Term (except for SPCEG013, which is examined in the Third Term).

ST Advanced Modules

During the second term (January - March) students take four Advanced Module options including at least 1 Systems module and 1 Applications module (see below). Each module lasts for approximately 27-30 hours (including tutorials, if given). Dates and times of all modules, and of the examinations for the short fat courses, are given in the Programme Timetable/Calendar. The examinations for the long thin courses (except for GEOGG141, see later) take place between the end of April and the beginning of June, and students will be notified in March of the times/dates/locations for these.
SYSTEMS MODULES

SPCEG007  Space-based Communication Systems – Dr. J. McEwen, Prof. A. Smith
SPCEG008  Spacecraft Design: Electronic Sub-systems – Dr I. Hepburn
SPCEG009  Mechanical Design of Spacecraft – Dr B. Shaughnessy, TBD
ELECGC01  Antennas and Propagation – Prof. K. Tong, Dr P. Brennan
ELEECGC16  Radar Systems – Prof. H. Griffiths

APPLICATIONS MODULES

GEOGG141  Principles and Practice of Remote Sensing – Dr M. Disney (note: this module is taught in the First Term and the exam normally takes place in January)
GEOGG142  Global Monitoring and Security – Prof. J.-P. Muller, Dr M. Disney
SPCEG001  Space Instrumentation and Applications – Prof. M. Cropper, Prof. A. Fazakerley, Dr K. al-Janabi, Dr I. Hepburn, Dr D. Kataria, Prof. J.-P. Muller, Prof. L. Harra
SPCEG002  Space Plasma and Magnetospheric Physics – Prof. A. Fazakerley, Dr J. Rae


SS Advanced Modules

During the Second Term (January - March), all students take the Space Instrumentation & Applications module SPCEG001. Students also take 3 other space science Advanced Modules from those listed below. Each module lasts for approximately 30 hrs and examinations are in the Third Term (except for GEOGG141). Dates and times of these modules are given in the Programme Timetable/Calendar. Students will be notified in March of the times/dates/locations for the summer exams, which take place between the end of April and the beginning of June.

COMPULSORY MODULE

SPCEG001  Space Instrumentation and Applications – Prof. M. Cropper, Prof. A. Fazakerley, Dr K. al-Janabi, Dr I. Hepburn, Dr D. Kataria, Prof. J.-P. Muller, Prof. L. Harra

SPACE SCIENCE MODULES

SPCEG011  Planetary Atmospheres – Dr G. Jones
SPCEG012  Solar Physics – Dr D. Williams, Dr S. Matthews
SPCEG013  High Energy Astrophysics – Dr S. Zane (note: this module is taught in the First Term)
SPCEG002  Space Plasma and Magnetospheric Physics – Prof. A. Fazakerley, Dr J. Rae
GEOGG141  Principles and Practice of Remote Sensing – Dr M. Disney (note: this module is taught in the First Term and the exam normally takes place in January)
GEOGG142  Global Monitoring and Security – Prof. J.-P. Muller, Dr M. Disney

Lecturers will recommend suitable textbooks during their courses. One book that gives a good general introduction to the whole field is *Space Science*, edited by L. Harra and K. Mason, published by Imperial College Press (2004). This book has 14 chapters on different aspects of Space Science, each written by a member of staff at MSSL.
Project Work

Individual Project (SPCEG099)

Students start work on an Individual Project during the first term.

This may involve attachment to any of the relevant Departmental Research Groups:

ST: S&CP or E&EE
SS: S&CP, Physics and Astronomy, or Earth Sciences (by special arrangement).

General Notes

- Some set topics for Individual Projects have been selected by potential supervisors, and a list will be available during the first term. Alternatively students can suggest areas in which they are interested. It is, however, essential that the subject of the chosen project is relevant to the Programme, and a willing supervisor is also required. Discussions with the Programme Team and potential supervisors start in October and a project title must be defined, and a supervisor appointed, by mid-November at the latest (see the exact deadline on the Programme Timetable/Calendar). Work begins in the First Term, usually with a literature survey or other background work. Progress, plans and difficulties are outlined in an Initial Report and a second, Interim Report, due at the end of the First and Second Terms respectively (see the Programme Timetable/Calendar for the exact dates). Part of the Individual Project are also: a) A presentation, given to an audience of staff and students of the S&CP and E&EE Departments (as appropriate) about one month before the Final Report submission deadline, and b) The Final Report.

ALL COMPONENTS OF THE INDIVIDUAL PROJECT HAVE TO BE SUBMITTED IN ORDER FOR THE PROJECT TO BE DEEMED COMPLETE.

Assessment of the Individual Project is based on the Final Report (70% of available marks), the Interim Report (20%) and the presentation (10% of the assessment).

- The Individual Project is a piece of research related to your MSc subject, and as such, students are expected to demonstrate initiative, originality of approach and deduction, although at a level, and within a timescale, appropriate to an MSc (rather than a PhD).

- THE AVAILABLE TIME IS SHORTER THAN IN MOST OTHER MSc PROGRAMMES (this is because of the 7 weeks taken up afterwards by the Group Project). Therefore you will start your project work much earlier than on most other MSc programmes.

- The Individual Project counts for one third of the assessment of the whole MSc (see page 5). As part of the pass criteria, the Individual Project must be passed with a mark of at least 50% to obtain an MSc (60% for a Merit and 70% for a Distinction).

- DO NOT LEAVE NEARLY ALL THE WORK TO THE LAST FEW WEEKS. Spread your project work between the three terms as suggested below.

- MAINTAIN REGULAR CONTACT WITH YOUR SUPERVISOR to ensure that the project remains “on course”, i.e. with the correct work being done, on schedule.

Summary of Deadlines and Deliverables

- Early in First Term ➔ Identify supervisor and project title
- End of First Term ➔ Project Initial Report submission
- End of Second Term ➔ Project Interim Report submission
- About mid-June ➔ Mid-Term Presentation
- About mid-July ➔ Project Final Report submission
Work in the First Term

- By the “project definition” deadline (see the Programme Timetable/Calendar for the exact date), define your project, in consultation with a potential supervisor, using the information and list that will be provided. Try to choose something that interests you – it may be useful to look at previous years’ reports (some may be available upon request from the Programme Administrators). If you need more help, ask one of the Programme Tutors.

- Email the title of the project, and your supervisor’s name and Department, to the Individual Project Tutor, Prof. Kinwah Wu (k.wu@ucl.ac.uk) and to the Programme Administrator, Ms Libby Daghorn (l.daghorn@ucl.ac.uk) by the “project definition” deadline (see the Programme Timetable/Calendar for the exact date). Ask your Project supervisor to confirm this by emailing both k.wu@ucl.ac.uk and l.daghorn@ucl.ac.uk.

- Try to complete the literature review and any other preliminary tasks in the First Term. Start the main project work if possible.

- Email (in Word or pdf format) a 2 to 4 page (not including space taken by graphics and tables) PROJECT INITIAL REPORT to Libby Daghorn (l.daghorn@ucl.ac.uk) by the deadline, at the end of the First Term (the actual date will be listed in the Programme Timetable/Calendar). THIS INITIAL REPORT IS IMPORTANT BECAUSE IT WILL FORM THE BASIS OF THE ASSESSMENT AND FEEDBACK PROVIDED BY THE PROGRAMME TEAM AT THE PROGRESS MEETING EARLY IN THE SECOND TERM. YOU MUST AGREE THE CONTENTS OF THIS REPORT WITH YOUR SUPERVISOR BEFORE SUBMITTING IT

Work in the Second Term

- Aim to work at least 1 day per week on the project during the Second Term.

- Aim to have completed about 25% of the project work by the end of the Second Term.

- Submit one file (a Word document or pdf, via Moodle) containing your PROJECT INTERIM REPORT (a maximum of 3,000 words long, not including Figures, Tables and Reference list – Include the total number of words in the Report on the front page) by the deadline, at the end of the Second Term (see the Programme Timetable/Calendar). THIS IS A REAL DEADLINE - STUDENTS WILL BE PENALISED (MARKS SUBTRACTED) FOR LATE SUBMISSION OF THE REPORT.

- Note the following:
  - The report should have 3 sections (section 2 being the largest):
    1. A brief introduction to the project, including a brief outline of the envisaged work;
    2. A description of the work completed to date, with any conclusions;
    3. A summary of the work still to do, with a provisional contents list for the Final Report, and an updated project schedule.
  - You should discuss the contents and style of this report with your supervisor before writing it and at the draft stage, but it will be assessed, so it must be your own work.

THE LENGTH OF THE REPORT IS IMPORTANT: 3,000 WORDS IS A HARD MAXIMUM AND STUDENTS WILL BE PENALISED FOR EXCEEDING IT (see page 13). THE INTERIM REPORT ACCOUNTS FOR 20% OF THE AVAILABLE PROJECT MARKS. NOTE: It can make the difference between Pass and failure, or Pass and Distinction!
Work in the Third Term & the Summer Period

- Work full time on the Individual Project, and complete it, after the summer exams. Discuss any difficulties with your supervisor WELL IN ADVANCE OF THE FINAL REPORT DEADLINE.

- Prepare, in consultation with your supervisor, a PRESENTATION on your project work, to be delivered about a month before the Final Report submission deadline (the date will be posted in the Programme Timetable/Calendar), to an audience of academics, scientists, engineers and postgraduate students. It is expected that following the presentation students will receive feedback on their project work that can be incorporated into their Final Report.

  THE MARK ON THE PRESENTATION ACCOUNTS FOR 10% OF THE OVERALL PROJECT MARK.

- Discuss the structure of your FINAL REPORT (i.e. its sections and subsections) with your supervisor at an early stage. The detailed structure may vary depending on the subject, but should always include:
  - An Abstract, which is a concise summary of your Report and its results (in no more than 300 words), at the beginning of the Report.
  - An introductory section which states the aims and objectives of the project, discusses the rationale for the project (including how it relates to previous work) and outlines what is covered by each main section in the Report.
  - A concluding section which discusses the extent to which the main results and discussion meet the aims and objectives of the project, and discusses any possible future research that could follow on from the project.

- Complete a draft of the Report well before the deadline to allow for proof reading and alterations.

- A template will be issued for the front cover. All Reports should have a cover conforming to this.

- The Final Report should be produced in a font such as Times New Roman (font size 12) or Arial (font size 10), with 1.0 or 1.5 line spacing. Any Figures or Tables should be labelled and numbered, and each of these must be referred to in the text by number. References should be referred to in the text and in the reference list at the end of the Report in a conventional way (as in scientific papers – if in doubt, ask your supervisor for advice). Pages must be numbered.

- Your Final Report must be between 10,000 and 12,000 words long, excluding table of contents, list of figures, figures and tables, and their captions, reference/bibliography lists and appendices. Include the total number of words in the Report on the front page.

  AGAIN, THE LENGTH OF THE REPORT IS IMPORTANT: 12,000 WORDS IS A HARD MAXIMUM AND STUDENTS WILL BE PENALISED FOR EXCEEDING IT (see page 13).

  THE FINAL REPORT ACCOUNTS FOR 70% OF THE OVERALL PROJECT MARK.

Submission of the Final Report

- Provide 3 bound copies of your project FINAL REPORT by the deadline date (usually around mid-July – see the Programme Timetable/Calendar), handing them in at the offices at 3 Taviton St.

- An electronic copy of the Final Report should also be submitted via Moodle by the same deadline (file type and size restrictions may apply).

  THIS IS A REAL DEADLINE – STUDENTS WILL BE PENALISED (MARKS SUBTRACTED) FOR LATE SUBMISSION OF THE FINAL REPORT

- You should be aware that the Department uses a sophisticated detection system (Turnitin® [xix]) to scan work for evidence of plagiarism (see later section about ‘Plagiarism’). This system has access to billions of sources worldwide (Websites, journals, etc.) as well as work previously submitted to this Department and other Departments.
The Final Report will be assessed (independently by 2 markers) for its main content (including originality, analysis and discussion of results), for its introductory content (including introduction, problem definition and references), and for its style (including structure, literary style and presentation). The assessment of the first marker (your supervisor) will also take into account the effort and initiative that you put into your project.

To summarise, assessment of the Individual Project is based on three components:

1. The Interim Report (providing 20% of the overall Individual Project mark)
2. The Mid-Term Presentation (10%)
3. The Final Report (70%)

Group Project (SPCEG089)

Supervisor: Dr. D. Williams

For the final 7 weeks of the MSc Programme, students on the ST Pathway combine with those on the SS Pathway to carry out a Group Project, generally an industrial-style space mission design study (similar to a “Phase A” feasibility study), at which they all work together as part of a team. Weekly meetings are held with the supervisor to monitor progress and help to solve the problems that may be encountered.

STUDENTS MUST MAKE SURE TO BE PRESENT IN LONDON OVER THIS PERIOD (~MID JULY TO MID SEPTEMBER).

A Report (60,000 words maximum – Include the total number of words in the Report on the front page) is written and the study is presented and assessed by a panel of experts, including some from outside UCL, during a formal Design Review. Each student is expected to give part of the presentation. The presentation and Review are held just at the end of the Programme’s year. By way of an introduction to the Programme, students about to join the Programme the following year are invited to attend the current year’s Group Project Presentation.

More details about the organization of the Group Project, including its key dates, will be provided later in the year.

Assessment of the Group Project is based on four components:

1. The Final Report (60%),
2. The Presentation (15% - each student is marked individually on their performance),
3. Team work (10% - each student is assessed individually by the supervisor on their performance during the weekly meetings)
4. Peer assessment (15% - more details will be provided closer to the time)

Module Assessment and Examinations

Assessment of work will take two forms: assignments set during each module, marked and returned to the student with feedback, and “closed-book” examinations consisting of unseen questions based on the syllabus.

The in-module assignments allow tutors to give constructive feedback about each student’s progress.

Feedback is also given in a specific individual tutorial, the Progress Meeting with the Programme Team early in the Second Term, which is held to review the student’s performance in the First Term and to discuss their project Initial Report. Modules “closed-book” examinations follow standard UCL practice: detailed feedback is not given.

The main opportunities to receive feedback about the Individual Project are the comments and suggestions given on the Interim Report and at the Mid-Term Presentation. This feedback should be noted carefully.
Plagiarism

The presentation of another person's thoughts or words or artifacts or software as though they were your own is a very serious offence known as plagiarism.

Plagiarism is taken extremely seriously by the Departments and by UCL, as well as in the academic and publishing world at large. If a student is found to have carried out plagiarism, it can lead to the student not being awarded a degree, and being excluded from all future examinations at UCL and/or the University of London.

It should be noted that “presenting of others’ work as your own work” is a very wide-ranging concept. It includes, for example, the copying of text or figures from Websites, articles or books as part of a review or methodology description in a Project Report. Such copying is completely unacceptable, even if there is no intention to deceive the reader as to its origin. Any such material must be referenced in the Report and, if text, either presented in quotation marks, or not directly quoted at all. If in doubt, consult your supervisor or the Programme Team about what is acceptable and normal practice; do not jeopardise your future through ignorance or uncertainty.

For more detailed information concerning plagiarism, students are strongly advised to read the relevant section on the UCL website [i].

You should be aware that the Department uses a sophisticated detection system, Turnitin® [ii], to scan work for evidence of plagiarism. This system has access to billions of sources worldwide (Websites, journals, etc.) as well as work previously submitted to this Department and other Departments.

For this MSc/Diploma/Certificate Programme the use of Turnitin® affects essays and project Reports, and means that you may have to submit electronic copies of work in addition to paper copies. You will be told during each relevant module how this will be organised and what file formats will be acceptable.

Candidate Codes

For the purposes of anonymity during standard UCL examinations, students are issued with alphanumeric codes which are written on papers. In this way, the markers will not know who has written each script. The Programme tutors and administrators will however have access to the names and candidate codes.

Absence

Attendance on all components of the Programme is mandatory, and it is not possible to repeat a missed course or examination during the same academic year. If a student needs to be absent from UCL for any reason, he/she must inform the Programme Team, and explain the reason. Absence during the Group Project is only permitted in very exceptional circumstances.

Extenuating Circumstances

Any circumstances likely to affect your examination performance should be notified in writing, on a form that can be obtained from the Programme Team, with appropriate supporting documentation, to the Programme Team no later than one week after the end of the examination in question. These circumstances will be considered in strict confidence.

Circumstances which have already been brought to the attention of the Board of Examiners and for which allowance has already been made (e.g. extra time allowed because of dyslexia, extension of deadline for coursework) should not be notified in this way. The examiners will be aware of these circumstances, but any circumstances which might affect your examination performance can be taken into account only once for each annual cycle of examinations.

Deferral of Examinations or Interruption of Study

In exceptional circumstances beyond the student’s control (e.g. illness), and at the discretion of the UCL authorities, students may be permitted to defer (postpone) examinations [iii].
In various circumstances UCL may, at its discretion, grant an Interruption of Study, usually for one year [iv]. If you think it may be necessary to apply for either of these possibilities, please discuss this first with the Programme Tutor.

**Calculators in Examinations**

Only certain specific electronic calculators may be used during examinations at UCL, namely the Casio FX83WA, FX83MS or FX83GT+ (battery powered) and Casio FX85WA, FX85MS or FX85GT+ (solar powered). All students on the MSc/Diploma/Certificate Programme should use one of these calculators in the exams. Mobile phones, personal organisers, etc. are not permitted as substitutes, nor is any programmable calculator.

The mandated models are economically priced and are available from various outlets in UCL, including the UCL shop in South Junction [v] and in the basement of the Bloomsbury Theatre.

- Please make sure you buy one of these before your first exam.

**Penalties**

**Penalties for late submission of coursework**

Extract from UCL regulations:

The full allocated mark should be reduced by five percentage marks for the first working day after the deadline for the submission of the coursework. The mark will be reduced by a further ten percentage marks if the coursework is submitted during the following six days. In the case of coursework submitted more than seven days late, the mark will be recorded as zero, but the assessment would be considered to be complete, providing that the coursework contains material that can be assessed.

**Penalties for exceeding and being under the prescribed word count**

Extract from UCL regulations:

For work that exceeds or is under the word limit by 10% or more, a mark of zero will be recorded.

For work that exceeds or is under the word limit by less than 10% the mark will be reduced by ten percentage marks; however, the penalised mark will not be reduced below the pass mark, assuming the work merited a pass.
Lecture Module syllabus details

Refer to the table on page 5 summarising the MSc/Diploma/Certificate Programme structure for details of which modules apply to the two Pathways. Some modules are present in both Pathways: in such cases, the descriptions below appear only once. This syllabus is for guidance only: lecturers may on occasion make minor changes.

Core Modules syllabus summaries

SPCEGC01: SPACE SCIENCE, ENVIRONMENT AND SATELLITE MISSIONS

Lecturers: Dr S. Matthews, Prof. A. Coates, Mr M. Whyndham

Credits: 15  Teaching Term: 1

Assessment method and timing: 20% coursework, 80% examination in Term 3

This module will give students an appreciation of the history of early spaceflight and examples of early space science satellites; will lead students to understand different space science fields, and will equip them with basic knowledge of the spacecraft environment, of spacecraft dynamics, rocket propulsion, spacecraft design and the essential spacecraft sub-systems; will inform them about space mission planning and space project management. This knowledge is the necessary pre-requisite to develop a good understanding of the advanced topics taught in Term 2 of the MSc Programme.

Topics covered by the module:

- Space science and other space applications. Brief history of early spaceflight to 1961. Examples of early space science satellites: Ariel 1, Orbiting Observatories, European programme. Brief outline descriptions of the following space science fields, with major related space science missions and discoveries: solar physics, space plasmas (solar wind and Earth’s magnetosphere), solar system exploration (moons, planets, asteroids and comets), astrophysics from space, Earth observation from space (remote sensing).

- The spacecraft environment - Earth’s atmosphere, equation of hydrostatic equilibrium, measurements of density, atmospheric drag. The ionosphere and solar radiation, the trapped particle zone (radiation belts). The magnetosphere, the Sun and the solar wind.

- Spacecraft dynamics - Orbits, trajectories and launching. The nature of satellite orbits and elementary orbit theory, perturbations. Rocket propulsion - the rocket equation, propellants and specific impulse, nozzle design, staging.


- Project management - organogramme, work packages, schedule. PERT network, milestones, critical path, progress meetings, expenditure profiles and financial control.

- Mission planning and operations, science planning, timelining, ground support

SPCEGC02: SPACE SYSTEMS ENGINEERING

Lecturers: Mr M. Whyndham, Dr I. Hepburn

Credits: 15  Teaching Term: 1

Assessment method and timing: 20% coursework, 80% examination in Term 3

The aim of this module is to provide an understanding of how a spacecraft operates from a technological perspective. This will necessitate exploring the physical, mathematical and engineering principles used in the operation of the major subsystems of a modern spacecraft. On completion of the module the student will be able to describe in some detail the major subsystems of a spacecraft, calculate the basis of operation of these, develop simple models of their functional scope and relate these to simple scientific or operational goals of space missions.

Topics covered by the module:
Systems engineering lifecycle, structure and management of systems development projects and programmes, management of requirements and interfaces. Technology selection, development, insertion and trade-off.

Review of scientific spacecraft subsystems, with examples from modern space vehicles. Spacecraft and instrument design constraints and evolution - size, mass, geometry, power, apertures, thermal control, surface requirements, booms, e-m properties, command capability, data rate.

Mechanical sub-systems: the mechanical environment and design.

Electrical sub-systems: power sub-system and other electronic sub-systems, including analogue signal amplification and processing.

The spacecraft thermal environment and design considerations and methods. Cooling methods and refrigeration.

Attitude control and station keeping, and the basic technology of attitude sensors.

Quality management in the space domain, qualification and integration activities. Component, sub-assembly, instrument and spacecraft level tests. Vibration, temperature, vacuum, solar simulation tests. Configuration management.

Product assurance: approved parts and materials lists, cleanliness, testing, protection during shipping, documentation.

Commanding and data acquisition. Data relay satellites, ground stations, control centre requirements.

Digitised signal data, On-Board Data Handling (OBDH), telemetry and telecommanding, including encoding and command decoding, error detection and correction, RF satellite communications links and link budgets.

**SPCEGC03: SPACE DATA SYSTEMS AND PROCESSING**

**Lecturers:** Prof. L. Harra, Dr P. Groves, Prof. M. Ziebart, Prof. A. Smith, Dr I. Ferreras

**Credits:** 15  
**Teaching Term:** 1

**Assessment method and timing:** 20% coursework, 80% examination in Term 1

On successful completion of this module, students should have competence in understanding current applications of downstream data (in the areas specified below), finding and using space data, processing data products to acquire further scientific knowledge or make statements about the natural and human-made environments (mostly Earth’s, but not exclusively), combining data from many sources in support of such processes, stating limitations of given datasets, defining basic requirements for data systems (current and future).

This is a short, intensive module, run over five days, with 6 hours of lectures on a specific topic, and delivered by a different lecturer, each day. The five topics are:

1) **Positioning**  
Principles of positioning systems and practicalities. Applications (methods and uses): vehicles, ground transport in general, personal, navigation, metrology, asset management, security, defence services. Future developments and enhancements.

2) **Solar-Terrestrial Relationships**  
Terrestrial applications, Earth magnetosphere and space weather, solar cycle and activity in general (e.g. CMEs), NOAA reports, end users (e.g. aircraft and spacecraft operators, power lines on the ground). Science of space weather and solar-terrestrial relationships, possible connection between solar activity and Earth’s climate.

3) **Telecommunications**  
Communications and broadcast services and applications, an introduction; basic principles of space communications; data formatting and encryption; data security; orbits and coverage; communication bands, their application and allocation; radio-amateur satellites; National Space Technology Roadmap for telecoms; an anatomy of a telecoms satellite; partnerships and collaborators in a satellite TV broadcast.
4) **Earth Observations (EO) and Global Change**

Different purposes of EO, of which climate is one: weather monitoring and forecasting, defense, agriculture, natural resource exploitation, geographical science, disaster monitoring and predicting, urban and territory planning, climate and global change, importance of remote sensing.

5) **Astronomy**


**ELECGT02: COMMUNICATION SYSTEMS MODELLING**

**Lecturers:** Prof. K. K. Wong, Dr Y. Andreopoulos, Dr R. Clegg

**Credits:** 15  
**Teaching Term:** 1

**Assessment method and timing:** 50% coursework, 50% examination early in Term 2

This module introduces students to the techniques and tools used to model and simulate today’s communications systems and networks. Consideration is given to both the Physical Layer and the Network Layer and the module looks at the theory of modelling and practical applications using standard simulation packages. This module provides in-depth exposure to analytic and simulation techniques appropriate for the representation, analysis and performance evaluation of communications systems and networks (e.g. using MATLAB simulation tools).

Topics covered by the module:
- Methods of Performance Evaluation
- Simulation Approach: Waveform-Level Simulation of Communication Systems
- The Application of Simulation to the Design of Communication Systems
- Methodology of Problem Solving for Simulation
- Basic Concepts of Modelling
- Error Sources in Simulation
- Simulation Environment and Software Issues
- Deterministic Signals and Systems
- Continuous and Discrete Time Signals
- Signals in the Time and Frequency Domains
- Fourier Series and Transforms
- Convolution
- Probability and Stochastic Processes
- Discrete and Fast Fourier Transform (DFT/FFT)
- Hilbert Transform
- The Complex Envelope
- Sampling
- Signal Design and Analysis
- Modelling and Simulation of LTI Systems
- Simulation of Filtering with FIR Filters
- Simulation of Filtering with IIR Filters
- Effects of Finite Word Length in Simulation of Digital Filters
- Time-Varying Linear Systems
- Modelling Considerations for Nonlinear Systems
- Memoryless Nonlinearities
- Nonlinearities with Memory
- Nonlinear Differential Equations
- Measurement Technique for Nonlinear Components
- Modelling with MATLAB
- Simulating the internet

**Advanced Modules syllabus summaries**

**ST Systems Modules (OPTIONS A)**

**SPCEG007: SPACE-BASED COMMUNICATION SYSTEMS**

**Lecturers:** Dr. J. McEwen, Prof. A. Smith

**Credits:** 15  
**Teaching Term:** 2

**Assessment method and timing:** 20% coursework, 80% examination in Term 3

SPCEG008: SPACECRAFT DESIGN - ELECTRONIC SUB-SYSTEMS

Lecturer: Dr I. Hepburn

Credits: 15  Teaching Term: 2

Assessment method and timing: 20% coursework, 80% examination in Term 3

Introduction - Comparison of spacecraft electronic systems to an equivalent ground based unit.

Power Systems - Solar cells, solar arrays; storage cells; regulation dissipative and non-dissipative, regulators linear and switched mode, noise reduction, filters, supply monitoring, decentralised regulation.

Attitude sensing and control - Earth and Sun sensors, charge coupled devices, wedge and strip, crossed anode, magnetic sensors, search coil and fluxgate, magnetic torquers.

Mechanisms & Housekeeping - Control monitoring; optical and magnetic, pyrotechnic actuators, bridge techniques.

Harnesses - EMC magnetic and electric coupling, shielding efficiencies for near and far field, EMC outgassing ports, connector types, low and high voltage, printed circuit board types.

Reliability - Design techniques, heat dissipation, latch-up, interface and single point failures, housekeeping requirements, components specification, failure rates, fabrication, radiation testing, effect of radiation, displacement and ionisation damage, transients effects, designing for radiation protection.

Analogue design - Charge sensitive amplifiers, noise considerations, practical circuits, pulse shaping circuits, unipolar and bipolar pulses, base line depression, pulse pile-up, low frequency measurements.

Example sessions - Electrical hardware circuits for past and present space missions will be described and demonstrated utilizing the project's development circuit boards.

SPCEG009: MECHANICAL DESIGN OF SPACECRAFT

Lecturers: Dr B. Shaughnessy, TBD

Credits: 15  Teaching Term: 2

Assessment method and timing: 20% coursework, 80% examination in Term 3

Spacecraft configurations - Interplay of mission, solar power requirements, attitude system and launch vehicle. Mechanical interfaces. Subsystems.

Launch accelerations, acoustic fields, vibrations - cases, loads and factors.

Foundations of stress analysis and mechanics of materials - Examples of application to spacecraft.

Frame structure and analysis - Strut buckling and optima. Shell structure and analysis - Finite elements. Sandwich panels theory and practice.

Materials for lightness, space vacuum and the radiation environment - Metals, polymers, ceramics and composites. Cryogenics and low temperatures.

Nuts, bolts and joints generally. The deployment of booms, arrays and antennas.

Mechanisms - Elements, kinematics, kinematic design.

Bearings - Sliding, rolling and flexing. Space lubrication.


Vibration theory for space technology - Single degree of freedom frequency, damping, transmissibility. Response of systems with 2 or more systems. Random excitation and response.


ELECGC01: ANTENNAS AND PROPAGATION

Lecturers: Prof. K. Tong, Prof. P. Brennan

Credits: 15  
Teaching Term: 2

Assessment method and timing: 25% coursework, 75% examination in Term 2

Definitions: Gain, directivity, efficiency, effective area & length; directional patterns; polarisation; Hertzian dipole reactive and far field patterns; types of radiating element; Fourier transforms in antennas, displacement theorem, amplitude tapers & sidelobe levels; orthogonality, pattern synthesis; near and far field patterns, focussed apertures. Arrays and Electronic Beam Control: Interferometers, linear arrays, product theorem; frequency-scanned array, phase & time delay compensation, null steering; switched-line phase shifter & sidelobe levels, vector modulator; multiple beamforming arrays. Digital beamforming: smart antenna systems in mobile applications. Reflector and Lens Antennas: Reflector antennas, feed systems; lens antennas. Antenna Measurements: Anechoic chambers, far-field definition; gain, three-antenna measurement; impedance & polarisation. Other Antenna Topics: Pyramidal & corrugated horns; printed and helical antennas; slot antennas. Propagation Principles: Friis transmission formula; atmospheric effects; fading types and statistics; line-of sight microwave transmission; edge effects; application of propagation models in mobile communications to model urban, suburban and rural environments.

ELECGC16: RADAR SYSTEMS

Lecturer: Prof. H. Griffiths

Credits: 15  
Teaching Term: 2

Assessment method and timing: 100% examination in Term 2

Introduction: historical background, radar terminology, radar band designations
The radar equation: point targets, radar cross section, distributed targets, propagation, coverage diagrams
Noise, clutter and detection: theory of detection, sea and land clutter models, CFAR Processing.
Displays: A-scope, B-scope, PPI, modern displays
Doppler radar and MTI: Doppler effect, delay-line cancellers, blind speeds, staggered PRFs, Adaptive Doppler filtering
Pulse Doppler processing and STAP: airborne radar, high, low and medium PRF operation, Space-Time Adaptive Processing
Pulse compression: principles, the ambiguity function, the matched filter, chirp waveforms, SAW technology
Waveform design: nonlinear FM, phase codes, waveform generation and compression
FM radar: principles, radar equation, effect of phase and amplitude errors
Synthetic Aperture Radar: principles, SAR processing, autofocus, spotlight mode, airborne and spaceborne systems and applications, interferometry, ISAR
Tracking radar: conical scan, monopulse, - tracker, track-while-scan, Kalman filters
Avionics and radionavigation: Air Traffic Control, primary and secondary radar, GPS
Phased array radar: phased array principles, array signal processing, multifunction radar, scheduling
Electronic Warfare: ESM, ECM, ECCM; superresolution, IFM, types of jammers, calculation of performance, adaptive arrays, LPI radar
Stealth and counter-stealth: stealth techniques for aircraft and other target types, low frequency and UWB radar
Bistatic radar: bistatic geometry, bistatic radar equation, synchronisation, illuminators of opportunity
System design examples

ST Applications Modules (OPTIONS B)

SPCEGC03: SPACE DATA SYSTEMS AND PROCESSING

See page 15 for details and syllabus.
SPCEG001: SPACE INSTRUMENTATION AND APPLICATIONS
See page 20 for details and syllabus.

SPCEG002: SPACE PLASMA AND MAGNETOSPHERIC PHYSICS
This Space Science module is very relevant to Space Technology, with regard to the spacecraft environment and potential detrimental effects on spacecraft (e.g. spacecraft charging, space weather). The main physics background required is electromagnetism, including Maxwell’s Equations.
See page 22 for details and syllabus.

GEOGG141: PRINCIPLES AND PRACTICE OF REMOTE SENSING
Lecturer: Dr M. Disney
Credits: 15  
Teaching Term: 1
Assessment method and timing: 100% examination in early January
This module provides an introduction to the basic concepts and principles of remote sensing. It includes three components:

i) The geometric principles of remote sensing: geodetic principles and datums, reference systems, mapping projections distortions and transformations; data acquisition methods.

ii) The radiometric principles of remote sensing: electromagnetic radiation; basic laws of electromagnetic radiation; absorption, reflection and emission; atmospheric effects; radiation interactions with the surface; orbits; spatial, spectral, temporal, angular and radiometric resolution; data pre-processing; scanners. Introduction to radiative transfer, with focus on models of vegetation and terrestrial surface.

iii) Active remote sensing and time-resolved signals (Lidar and RADAR): Lidar: lidar principles; types of lidar system; advantages of lidar observations; information content; discrete return v waveform; current and future systems; ground-based lidar. RADAR: RADAR principles; time-resolved signals; the RADAR equation; RADAR resolution; phase information and SAR interferometry; microwave applications.

GEOGG142: GLOBAL MONITORING AND SECURITY
Lecturers: Prof. J.-P. Muller, Dr M. Disney
Credits: 15  
Teaching Term: 2
Assessment method and timing: 50% coursework, 50% examination in Term 3
The module provides an introduction to the current state-of-the-art in Global Monitoring of Environment and Security (which is the EU/ESA name for the Group on Earth Observations, GEO).
Aims of the module:
To define the objectives of a GMES system within the context of the GEOSS (Global Earth Observation System of Systems) and its nine societal benefit areas. To describe the scientific underpinning for many of these societal benefit areas, including improved weather forecasting, the monitoring of climate change and the monitoring and prediction of natural hazards. To investigate the needs for EO monitoring of human security concerned with transmigration of people, diseases and animals and what remote sensing tools and techniques exist to address these needs. To study the requirements for accurate calibration and validation of instruments to be able to address the needs of GMES, especially related to long-term monitoring. To describe the fundamental principles of data and system interoperability and to explore the role of OGC protocols within GMES. To assess the progress of the GEOSS 10 year Implementation Plan in the context of international programmes.
SS Compulsory Module

SPCEG001: SPACE INSTRUMENTATION AND APPLICATIONS

Lecturers: Prof. M. Cropper, Prof. A. Fazakerley, Dr K. al-Janabi, Dr I. Hepburn, Dr D. Kataria, Prof. J.-P. Muller, Prof. L. Harra

Credits: 15  Teaching Term: 2

Assessment method and timing: 20% coursework, 80% examination in Term 3

1. Spacecraft as observation platforms
   - Why go into space, space environment, space effects from Earth’s surface, in situ measurements, remote sensing, space as a laboratory, impact of space studies.
   - Systems approach to measurements: analysis, detection, signal processing, data encoding, control.
   - Spacecraft interface and subsystems: accommodation, attitude control, power conditioning.
   - Examples from solar system exploration.

2. Spacecraft-environment interactions
   - Spacecraft charging in low Earth orbit and geostationary orbit. Radiation damage effects.
   - Background effects and their minimisation. Plasma influx, penetrating radiation, sunlight.

3. In-situ plasma measurements
   - Requirements: Energy and mass analysis for charged species from 1eV to 1MeV. Neutral mass spectrometers.

4. Detectors and sensors for in-situ measurements
   - Channeltrons, microchannel plates, solid state detectors, charge coupled devices, current collectors, antennas and probes, magnetometers and electric field sensors

5. Planetary analysis
   - Nuclear remote and in-situ measurement techniques. Introduction to planetary analysis, spectroscopy: \( \gamma \)-ray, X-ray, \( \alpha \)-particle, neutron, Mossbauer. Visible light & dust particle measurement techniques. Imagers, experimental platforms, future missions, dust detectors. Radar instrumentation and chemical analysis.

6. Atmospheric measurements
   - Basic physics and chemistry, spectroscopy, practical instrument examples, applications of fundamental principles to measurements

7. Detectors and sensors for astrophysics
   - Radiometry, solid state physics, cooling, intrinsic and extrinsic photoconductors, radiation effects, stressed photoconductors, photodiodes, photoemission detectors, photomultipliers, image intensifiers, bolometers, coherent detectors, amplifiers; Attitude and position sensing: sun sensors, earth sensors, star sensors, magnetometers, attitude control

8. Astronomical observations (astrophysics, UV/optical/IR)
   - Radio, Microwave and Sub-millimeter, Far Infra-red and Infra-red, Visible and UV, X-ray, Gamma-ray, Formation Flying, Cryogenics

9. Solar measurements
   - Remote sensing instrumentation for studying the Sun. Motivation for observing the Sun, detectors used, telescope designs, instrumentation from the optical to gamma-ray wavelength ranges, future solar instrumentation.

10. Onboard and ground data processing
    - System overview, onboard data processing, data compression techniques, on-board data handling (OBDH) and telemetry systems, spacewire, ground systems

11. Case studies I: Case studies of missions

12. Case studies II: Student presentations of case study missions

SS OPTION Modules

SPCEG011: PLANETARY ATMOSPHERES

Lecturers: Dr G. Jones

Credits: 15  Teaching Term: 2
Assessment method and timing: 10% coursework, 90% examination in Term 3

Comparison of planetary atmospheres - competition between gravitational attraction and thermal escape processes; factors which differentiate between planetary atmospheres; energy and momentum sources; accretion and generation of gases; loss processes; dynamics; composition.

Atmospheric structure - hydrostatic equilibrium; adiabatic lapse rate; stability; radiative transfer; the greenhouse effect and the terrestrial planets.

Oxygen chemistry - ozone production by Chapman theory; comparison with observations; ozone depletion and the Antarctic ozone hole.

Atmospheric temperature profiles - troposphere, stratosphere, mesosphere and thermosphere described; techniques of measurement for remote planets; use of temperature profiles to deduce physical processes.

Origin of planetary atmospheres and their subsequent evolution - formation of the planets; primeval atmospheres; generation of volatile material; evolutionary processes; consideration of terrestrial and outer planets.

Atmospheric dynamics - equations of motion; atmospheric circulation and storms; dynamics of the atmospheres of the outer planets; comparison of the behaviour of wet and dry air; formation of clouds and rain; orographic effects.

Ionospheres and magnetospheres - ionisation and recombination processes; formation of a Chapman layer; interaction of the solar wind with planets and atmospheres.

Atmospheric loss mechanisms - exosphere and Jeans escape; non-thermal processes.

Extrasolar planetary atmospheres.

Observational techniques - occultation methods from UV to radiofrequencies; limb observation techniques in the UV, visible, IR and microwave spectrum.

Global warming - recent trends and the influence of human activity; carbon budget of the Earth; role of the oceans in climate moderation; positive and negative feedback effects; climate history; the Gaia hypothesis; terraforming Mars.

SPCEG012: SOLAR PHYSICS

Lecturers: Dr D. Williams, Dr S. Matthews

Credits: 15   Teaching Term: 2

Assessment method and timing: 10% coursework, 90% examination in Term 3

Introduction to solar physics: basics and properties of the Sun.


Reflection of acoustic waves in the interior, oscillations, helioseismology. The structure of the solar interior as deduced from helioseismology. Improving the Standard Solar Model with input from helioseismology.


Solar activity and solar magnetic cycle. Sunspots and active regions. Observations of the high and low
temperature aspects of flares - thermal and non-thermal phenomena, particle emission, mass motions, magnetic field changes. Pre-flare energy storage, role of the magnetic field. Energy release mechanisms, role of current sheets and magnetic field dissipation. Hard X-rays from flares, energetic particles and their acceleration. Chromospheric evaporation.

Coronal mass ejections - observations and models. Association with flares. Energetics. Travel into the heliosphere and interaction with the Earth. Space weather.


SPCEG013: HIGH ENERGY ASTROPHYSICS
Lecturer: Dr S. Zane

Credits: 15  
Teaching Term: 1
Assessment method and timing: 10% coursework, 90% examination in Term 3

This is a rather mathematical module, so students need to be familiar with vector calculus, tensor calculus, basic formalism of General Relativity, special functions and Fourier transforms, Lagrangian formalism, electromagnetism, radiative transfer.

Topics covered by the module:
The scope of high energy astrophysics. Prerequisites, units.

Blackbody radiation.

Classic Electromagnetic theory, wave equations, vector and scalar potential.

Special relativity and four-momentum, aberration and Doppler effects.

General relativity and black holes: Space-time and metric, Schwarzschild and Kerr black holes. Properties of the event horizon, Ergospheres.


Plus a selection of the following topics:

Cosmic rays: Origin, spectrum, angular distribution.

Supernovae: Stellar collapse, Supernova remnants, evolution and observational properties.

Neutron stars: Model, Pulsars, Magnetars.

Accretion onto compact objects: Eddington limit, Bondi accretion flows.

Jets.

New generation astrophysics: Gravitational wave astronomy, Neutrino astrophysics.

SPCEG002: SPACE PLASMA AND MAGNETOSPHERIC PHYSICS
Lecturers: Prof. A. Fazakerley, Dr J. Rae

Credits: 15  
Teaching Term: 2
Assessment method and timing: 10% coursework, 90% examination in Term 3

Available as an Applications Module option in the ST Pathway.

Introduction - Plasmas in the solar system, solar effects on Earth, historical context of the development of this rapidly developing field

Plasmas - What is a plasma, and what is special about space plasmas; Debye shielding, introduction to different theoretical methods of describing plasmas

Single Particle Theory - Particle motion in various electric and magnetic field configurations; magnetic mirrors; adiabatic invariants; particle energisation
Earth’s Radiation Belts - Observed particle populations; bounce motion, drift motion; South Atlantic Anomalty; drift shell splitting; source and acceleration of radiation belt particles; transport and loss of radiation belt particles

Introduction to Magnetohydrodynamics - Limits of applicability; governing equations; convective derivative; pressure tensor; field aligned currents; frozen-in flow; magnetic diffusion; fluid drifts; magnetic pressure and tension; MHD waves

The Solar Wind - Introduction, including concept of heliosphere; fluid model of the solar wind (Parker); interplanetary magnetic field and sector structure; fast and slow solar wind; solar wind at Earth; coronal mass ejections

Collisionless shocks – Shock jump conditions, shock structure, shock examples

The Earth’s magnetosphere and its dynamics – Magnetospheric convection, magnetospheric currents, the magnetopause, open magnetosphere formation, magnetosphere-ionosphere coupling, non-steady magnetosphere

The Solar Wind Interaction with Unmagnetised Bodies - The Moon; Venus, Comets

**GEOGG141: PRINCIPLES AND PRACTICE OF REMOTE SENSING**
See page 19 for details and syllabus.

**GEOGG142: GLOBAL MONITORING AND SECURITY**
See page 19 for details and syllabus.
Notes and References

i  UCL and Plagiarism: http://www.ucl.ac.uk/current-students/guidelines/plagiarism/

ii  Turnitin: http://www.turnitin.com/

iii  Deferral of examinations: http://www.ucl.ac.uk/current-students/exams_and_awards/GI/deferral_exam

iv  Interruption of Study: http://www.ucl.ac.uk/current-students/services_2/registration_status

v  UCL shop: http://www.ucl.ac.uk/estates/ucl-shop/