1. **Title of the module**

*PH508 Spacecraft Design and Operations.*

1. **School or partner institution which will be responsible for management of the module**

*School of Physical Sciences*

1. **The level of the module (e.g. Level 4, Level 5, Level 6 or Level 7)**

*5*

1. **The number of credits and the ECTS value which the module represents**

*15 (7.5 ECTS)*

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

*Term 2.*

1. **Prerequisite and co-requisite modules**

*None*

1. **The programmes of study to which the module contributes**

*Physics (BSc, BSc with Foundation Year, MPhys, MPhys with Year Abroad) (OPTIONAL)*

*Astronomy, Space Science and Astrophysics (BSc, MPhys, MPhys with Year Abroad)*

*This is not available as a wild module*

1. **The intended subject specific learning outcomes.
On successfully completing the module students will be able to:**

*8.1 Knowledge and understanding of physical laws and principles, and their application to diverse areas of physics focussed on spacecraft design and operations. (A1)*

*8.2 Knowledge and understanding of aspects of the theory and practice of astronomy, astrophysics and space science, and of those aspects upon which astronomy, astrophysics and space science depends. (A2) (ASSA only)*

*8.3 An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions relevant to spacecraft science. (B1)*

*8.4 An ability to solve problems in physics using appropriate mathematical tools. (B2)*

*8.5 An ability to use mathematical techniques and analysis to model physical behaviour. (B4)*

*8.6 An ability to comment critically on how spacecraft are designed, their principles of operation, and their use to access and explore space. Also on how they are used in astronomy and astrophysics research. (B5) (ASSA only)*

*8.7 An ability to use mathematical techniques and analysis to model physical behaviour. (C2)*

*8.8 An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning. (C6)*

1. **The intended generic learning outcomes.
On successfully completing the module students will be able to:**

*9.1 Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems; an ability to formulate problems in precise terms and to identify key issues, and the confidence to try different approaches in order to make progress on challenging problems. Numeracy is subsumed within this area. (D1)*

*9.2 Analytical skills – associated with the need to pay attention to detail and to develop an ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly. (D4)*

1. **A synopsis of the curriculum**

*Aims:*

*(1) To provide a basic understanding of the major subsystems of a spacecraft system.*

*(2) To provide basic frameworks for understanding of spacecraft trajectory and orbits, including interplanetary orbits, launch phase and attitude control.*

*(3) To provide an awareness of the basic ideas of how space is a business/commercial opportunity and some of the management tools required in business.*

*SYLLABUS:*

*Low Earth Orbit Environment*

*The vacuum, radiation etc environment that a spacecraft encounters in Low Earth Orbit is introduced and its effect on spacecraft materials discussed.*

*Spacecraft systems*

*A basic introduction to spacecraft and their environment. Covers Spacecraft structures and materials, thermal control, power systems, attitude control systems, the rocket equation and propulsion.*

*Project management*

*This discusses: the evolving framework in which world-wide public and private sector space activities are conceived, funded and implemented. The basics of business planning and management.*

*Orbital mechanics for spacecraft*

*Students will find out how basic Celestial Mechanics relates to the real world of satellite/spacecraft missions. Following an overview of the effects of the Earth’s environment on a satellite, the basic equations-of-motion are outlined in order to pursue an understanding of the causes and effects of orbit perturbations. A description is given of different types of orbit and methods are outlined for the determination and prediction of satellite and planetary orbits. Launch phase is also considered, and the module concludes with an assessment of Mission Analysis problems such as choice of orbit, use of ground stations, satellite station-keeping and orbit lifetimes.*

1. **Reading List (Indicative list, current at time of publication. Reading lists will be published annually)**

*Spacecraft Systems Engineering; Fortescue, P.W., Stark, J.P.W. & Swinerd, G. (2011)*

*Orbital Motion; Roy, A.E. (2005)*

*Space Vehicle Design; Griffin, M.D. & French, J.R. (2004)*

*Space Mission Analysis and Design; Larson, W.J. & Wertz, J.R. (1992)*

*Satellite Technology and its Applications; Chetty, P.R.K. (1991)*

*Rocket and Spacecraft Propulsion; Turner, M.J.L. (2000)*

1. **Learning and Teaching methods**

*Contact hours: lectures (17 hours), workshop sessions (16 hours)*

*The module is expected to occupy 150 total study hours including the contact hours above*

*Achievement of module learning outcomes:*

* *Lectures (8.1-8.7, 9.1, 9.2)*
* *Workshop sessions (8.3-8.7, 9.1, 9.2)*
* *Self-study (8.8, 9.2)*
1. **Assessment methods.**

*Coursework 30% including ICT (In-course Tests) and independent work*

*Final (written, unseen, length 2 hours) exam 70%*

*The above assessments test students’ knowledge and understanding of laws and principles (8.1-8.3, 8.6, 9.2) and application of techniques to model behaviour and solve problems (8.3-8.5, 8.7, 9.1). In preparing for the assessments, students will need to manage their own revision using reference materials (8.8, 9.2)*

1. ***Map of Module Learning Outcomes (sections 8 & 9) to Learning and Teaching Methods (section12) and methods of Assessment (section 13)***

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** |  | *8.1* | *8.2* | *8.3* | *8.4* | *8.5* | *8.6* | *8.7* | *8.8* | *9.1* | *9.2* |  |  |
| **Learning/ teaching method** | **Hours allocated** |  |  |  |  |  |  |  |  |  |  |  |  |
| **Private Study** | *117* |  |  |  |  |  |  |  | **x** |  | **x** |  |  |
| *Lecture* | *17* | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  | **x** | **x** |  |  |
| *Workshop* | *16* |  |  | **x** | **x** | **x** | **x** | **x** |  | **x** | **x** |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Coursework* |  | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |  |
| *Exam* |  | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  |  |
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1. *The School recognises and has embedded the expectations of current disability equality legislation, and supports students with a declared disability or special educational need in its teaching. Within this module we will make reasonable adjustments wherever necessary, including additional or substitute materials, teaching modes or assessment methods for students who have declared and discussed their learning support needs. Arrangements for students with declared disabilities will be made on an individual basis, in consultation with the University’s disability/dyslexia student support service, and specialist support will be provided where needed.*
2. **Campus(es) or Centre(s) where module will be delivered:**

 *Canterbury*

**FACULTIES SUPPORT OFFICE USE ONLY**

**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

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| --- | --- | --- | --- | --- |
| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
| 23/05/16 | Minor | September 2016 | 12-14 | No |
|  |  |  |  |  |