CH504 Organic Reaction Mechanisms

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	75% Exam, 25% Coursework	Murray Dr A
1	Canterbury	Whole Year	I	15 (7.5)	70% Exam, 30% Coursework	Murray Dr A

Availability

This is not available as a wild module.

Contact Hours

24 lectures, 6 laboratory days, 2 hours of example classes, 2 hours of revision sessions.

Learning Outcomes

Knowledge and understanding of core and foundation scientific physical and chemical concepts, terminology, theory, units and conventions to chemistry and forensic science.
Knowledge and understanding of areas of organic chemistry (organic functional groups, organic materials and compounds, synthetic pathways) as applied to chemistry and forensic science.
An ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to organic reaction mechanisms and to apply such knowledge and understanding to the solution of qualitative and quantitative problems.
An ability to recognise and analyse novel problems related to organic reactions and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data.
Ability to recognise and implement good measurement science and practice and commonly used chemistry and forensic laboratory techniques.
Skills in the safe handling of chemical materials, taking into account their physical and chemical properties, including any specific hazards associated with their use and to risk assess such hazards.
Skills required for the conduct of standard laboratory procedures involved in synthetic and analytical work in relation to organic systems. The systematic and reliable documentation of the above. The operation of standard instrumentation used in the chemical and forensic sciences in relation to organic systems.
Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
Interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working. Self-management and organisational skills with the capacity to support life-long learning.
Study skills needed for continuing professional development and professional employment.

Method of Assessment

Coursework: 2 Assignments, 5 Laboratory write-ups 30%; Examination: 70%.

Preliminary Reading

G. Solomons, C. Fyhle, Organic Chemistry, 7th edition, New York, Chichester, Wiley,2000 + earlier editions
M. Jones, Jr., Organic Chemistry, 2000, W. W. Norton and Company, New York.
Lowry & Richardson, Mechanism and Theory in Organic Chemistry; 3rd ed., 1987, New York, London, Harper and Row. + earlier editions
J. March and M. B. Smith, "March’s Advanced Organic Chemistry: Reactions, mechanisms and structure", 5th ed, Wiley, 2001, + earlier editions.
Oxford Chemistry Primers: Willis & Wills: Organic Synthesis;
Further texts may be recommended for individual topics.

Pre-requisites

CH308 Molecules, Matter and Energy,CH309 Fundamental Chemistry for Physical Scientists, CH314 Introduction to Biochemistry and Drug Chemistry, PS381 Chemical Skills for Forensic Scientists OR CH382 Chemical Skills.

Synopsis *

You will study organic reactions and materials encountered in organic chemistry in depth. In particular, you will look at the organic chemistry of functional groups such as alcohols, ethers, carbonyl, amines and alkyl halides. You will also look at carbon-carbon forming reactions and strategies for synthesising target molecules. (Lab component.)

CH506 Chemical Identification Techniques

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	75% Exam, 25% Coursework	Holder Dr S
1	Canterbury	Whole Year	I	15 (7.5)	70% Exam, 30% Coursework	Holder Dr S
1	Canterbury	Whole Year	I	15 (7.5)	65% Exam, 35% Coursework	Holder Dr S

Availability

This is not available as a wild module.

Contact Hours

29 hours of lectures, 10 hours of workshops, 4 hours of example classes, 2 hours of revision sessions.

Total study hours 150.

Learning Outcomes

Knowledge and understanding of core and foundation scientific physical and chemical concepts, terminology, theory, units and conventions to chemistry and forensic science.
Knowledge and understanding of areas of analytical, physical, organic and inorganic chemistry as applied to chemistry and forensic science.
An ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to chemical identification techniques and to apply such knowledge and understanding to the solution of qualitative and quantitative problems.
An ability to recognise and analyse novel problems related to chemical identification and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data.
Ability to recognise and implement good measurement science and practice and commonly used chemistry and forensic laboratory techniques.
Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them.
Interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working. Self-management and organisational skills with the capacity to support life-long learning.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
Study skills needed for continuing professional development and professional employment.

Method of Assessment

Examination: 65%; Coursework: 4 Assignments, 2 workshop assignments 35%.

Preliminary Reading

Chang, Physical chemistry for the chemical and biological sciences.
Williams and Fleming, Spectroscopic methods in organic chemistry.
Abraham, Fisher and Loftus, Proton and carbon-13 NMR spectroscopy.
W. Kemp, Organic Spectroscopy (3rd Ed), Macmillan 1991.
Anthony R. West, Solid State Chemistry and Its Applications.

Pre-requisites

CH308 Molecules, Matter and Energy, and CH309 Fundamental Chemistry for Physical Scientists, CH314 Introduction to Biochemistry and Drug Chemistry, PS381 Chemical Skills for Forensic Scientists OR CH382 Chemical Skills.

Synopsis *

You will develop an understanding of the theory and application of techniques for chemical identification. You will study symmetry, nuclear magnetic resonance (NMR), gas chromatography (GC), mass spectrometry (GCMS), infrared and Raman spectroscopy, spectrophotometry/fluorimetry, basic diffraction methods and electron spin resonance.

CH530 Polymeric and Organic Materials

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	Shepherd Dr H

Availability

This is not available as a wild module.

Contact Hours

24 hours of lectures, 3 practicals (18 lab hours), 3 hours of drop-in sessions.

Private study 105 hours; Total study hours - 150

Learning Outcomes

Fundamental concepts relating to polymer chemistry.
Operating instrument and interpreting spectra from spectroscopic data.
Structure-property relationships liquid-crystal (LC) materials.
Synthetic approaches to polymers, LCs, and light emitting organics.
Concepts relating to spectroscopy
An ability to interpret spectroscopic data.
An ability to link chemical structure to experimental observables
The skills to perform practical experiments to gain spectroscopic information.
The skills to operate standard chemical instrumentation, record data, evaluate observations and errors.
A knowledge of basic spectroscopy; infra-red, UV-VIS, fluorescence.
An understanding of how polymers are synthesised and analysed.
More detailed understanding of small molecule synthesis approaches.
A knowledge of LC behaviour and how it relates to observable properties.
A basic understanding of device compositions.
An ability to make use of appropriate texts, or other learning resources as part of managing their own learning.
Problem-solving skills, 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.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework - 40% Exam - 60%

Preliminary Reading

G. Solomons, Organic Chemistry 11th Ed.
J. M. G. Cowie, Polymers: Chemistry and physics of Modern Materials 3rd ed.
Y. Jean, F. Volatron and J. Burdett, An introduction to molecular orbitals
S.-S. Sun, L. R. Dalton, Introduction to Organic Electronic and Optoelectronic Materials and Devices
P. J. Collins, M. Hird, Introduction to Liquid Crystals: Chemistry and Physics.

Pre-requisites

CH309 CH382/PS381, and CH314 as prerequisite; CH506 as co-requisite.

Synopsis *

Chemistry in context
Plastics, Liquid Crystals and Organic LEDs are ubiquitous in everyday life; your smartphone, tablet or television screen is likely an Organic LED. Here, the chemistry of these common materials is explored. Specifically, the structure and nomenclature of organic and inorganic macromolecules are covered, as well as polymer syntheses. The physical, chemical and mechanical properties of polymers, liquid crystals and light emitting materials are dissected and device structure of organic LEDs is deconvoluted.
(Lab component.)

CH531 Thermodynamics and Kinetics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	Alfredsson Dr M

Availability

This is not available as a wild module.

Contact Hours

Lectures are given by a variety of lecturers- 24 hrs; practical lab classes - 18 hrs; assignments - 50 hrs. Total number of study hrs - 150 hrs.

Learning Outcomes

The intended subject specific learning outcomes
An ability to understand and apply basic concepts in chemical thermodynamics.
An ability to predict the feasibility of a chemical reaction.
An ability to recognise the links between the macroscopic thermodynamic and microscopic statistical viewpoints.
An ability to understand electrochemical reactions and processing.
An ability to understand molecular reaction dynamics.
The skill to perform calculations using thermodynamic data.
The skill to perform practical experiments to gain thermodynamic information.
The skill to operate standard chemical instrumentation, record data, evaluate observations and errors.
An ability to present and interpret information graphically.

The intended generic learning outcomes
Problem-solving skills, 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.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework - 40% - 3 assignments (15%) and practicals (25%)
Final exam - 60%

Preliminary Reading

(i) P.W Atkins, Physical Chemistry,
(ii) R. Chang , Physical Chemistry for the Chemical and Biological Sciences

Pre-requisites

CH308, CH382 and CH320.

Synopsis *

The speed (kinetics) and energetics (thermodynamics) of a reaction are of central importance in chemistry. Here, we use thermodynamics and kinetics to predict whether a particular reaction would take place and its likely product yield. We also cover equilibrium constants, electrochemical cells, colligative properties, including elevation and depression of melting and boiling points, zero, first, second and third order reaction kinetics and statistical thermodynamics. Experiments are included to help to cement understanding. (Lab component.)

CH532		Spectroscopy and Bonding				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	Green Prof M

Availability

This is not available as a wild module.

Contact Hours

Lectures – 24 hrs; practical laboratory classes - 18 hrs.

Total study hours - 150 hrs.

Learning Outcomes

Knowledge and critical understanding of: basic quantum mechanical concepts, basic concepts of molecular symmetry and group theory, how to obtain and interpret spectra to calculate molecular parameters from spectroscopic data.

Intellectual skills: an ability to link quantum mechanical theories to experimental observables, an ability to interpret spectroscopic data, the skill to perform practical experiments to gain spectroscopic information, the skill to operate standard chemical instrumentation, record data and evaluate observations and errors.

Subject-specific skills: a knowledge of basic spectroscopy (microwave, infra-red, UV-VIS, Raman), an ability to perform calculations on molecular parameters from spectroscopic data, an ability to understand quantum mechanical concepts underlying bonding and energy transitions experimentally observed in spectroscopy, an ability to understand symmetry of molecules to determine spectroscopic data, an ability to make use of appropriate texts, or other learning resources as part of managing their own learning.

Problem-solving skills: 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.

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.

Personal skills: the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework – 40% (3 x lab practicals 25%, 2 x class tests 15%); Final examination – 60%

Preliminary Reading

P.W Atkins, Physical Chemistry
C. N. Banwell and E. M. McCash , Fundamentals of molecular spectroscopy
Y. Jean, F. Volatron and J. Burdett, An introduction to molecular orbitals

Pre-requisites

Students must have taken CH308, CH320 and CH382 before taking this module.

Synopsis *

This module will deepen your understanding of the fascinating world of quantum mechanics and symmetry. We explore how this gives rise to quantisation and selection rules, and go on to apply this to spectroscopic methods to understand structure and bonding including: rotational (microwave) spectroscopy, vibrational (IR and Raman) spectroscopy and electronic transitions (UV-vis, PES). The lab course will give you hands on experience of some of these quite abstract concepts, and will allow you to apply your spectroscopic skills to real chemical problems. (Lab component.)

CH533 Materials and Solid State Chemistry

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	Arnold Dr D

Availability

This is not available as a wild module.

Contact Hours

24 hours of lectures; 18 hours of laboratory classes.

Learning Outcomes

Crystal structures - An ability to describe the features of the most common crystalline structures.
Bonding in the solid state - An ability to identify different bonding contributions in the solid state.
How the structure and bonding determines the chemical properties of a compound – An ability to relate the crystalline structure with the bonding to predict materials properties.
An ability to describe different defect structures in the solid state and how they affect the materials properties.
An ability to interpret and draw phase diagrams.

The intended generic learning outcomes:
Problem-solving skills, 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.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

40% coursework: 2 assignments (15%), practicals (25%); 60% examination.

Preliminary Reading

West, A. Solid State Chemistry and its Applications
Smart, L. E. and Moore, E. A. Solid State Chemistry: An Introduction

Pre-requisites

CH308, CH382 or PS381

Synopsis *

The arrangement of atoms and defects in a solid governs its properties. Here, we cover the crystal structures and phase diagrams of solid materials. Bonding in solids is discussed, including metallic, ionic and molecular crystals, band theory, defects and non-stoichiometry. You will be introduced to the synthesis, properties and applications of a wide range of materials and their solid state reactions. Applications covered include catalysis, energy materials such as fuel-cells and Li-ion batteries, superconductivity and semiconductors and nanomedicine. (Lab component.)

CH604 Analytical Chemistry

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	90% Exam, 10% Coursework	Biagini Dr S
1	Canterbury	Whole Year	H	15 (7.5)	75% Exam, 25% Coursework	Biagini Dr S
1	Canterbury	Whole Year	H	15 (7.5)	100% Exam	Biagini Dr S
1	Canterbury	Whole Year	H	15 (7.5)	80% Exam, 20% Coursework	Biagini Dr S

Availability

This is not available as a wild module.

Contact Hours

30 hours of lectures, as well as coursework assessment guidance and revision classes on request.

Total hours: 150, including private study.

Learning Outcomes

Core and foundation scientific physical, biological and chemical concepts, terminology, theory, units, conventions, and laboratory methods in relation to the chemical and forensic sciences.
Areas of chemistry including analytical chemistry, including as applied to forensic analysis.
Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to analytical chemistry and to apply such knowledge and understanding to the solution of qualitative and quantitative problems.
Ability to recognise and analyse problems involving analytical chemistry and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data by a variety of computational methods.
The ability to collate, interpret and explain the significance and underlying theory of experimental data, including an assessment of limits of accuracy.
Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them.
Evidence recovery, preservation, analysis, and presentation to professional standards
Generic skills needed for students to undertake further training of a professional nature.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, correct use of units and modes of data presentation.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working. Self-management and organisational skills with the capacity to support life-long learning.
Study skills needed for continuing professional development and professional employment.

Method of Assessment

Examination: 75%; Coursework: 25%.

Preliminary Reading

G. D. Christian, Analytical Chemistry, 6th Ed. New York; Chichester, Wiley,2003.

D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Analytical Chemistry— An Introduction, 8th Ed. Fort Worth: Saunders College Publishing; 2004.

K. A. Rubinson and J. F. Rubinson, Contemporary Instrumental Analysis,1st Ed. Upper Saddle River (New Jersey): Prentice-Hall, 2000.

E. de Hoffman, J. J. Charette and V. Stroobant, Mass Spectrometry — Principles and Applications, 2nd edition, Chichester, Wiley, 2001.

Pre-requisites

CH506

Synopsis *

Here, you will be introduced to a variety of modern techniques used to understand the structure, properties and potential applications of materials. Analytical techniques include: atomic emission/absorption spectrometry, high-performance liquid chromatography (HPLC), capillary zone electrophoresis (CZE), ion chromatography, mass spectrometry and gas chromatography (GCMS), electro-analytical chemistry, optical microscopy, electron microscopy.

CH620 Chemistry Research Project

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	30 (15)	100% Project	Biagini Dr S

Availability

This is not available as a wild module.

Contact Hours

Project work (22 weeks).

Learning Outcomes

Principles and theories relating to Chemical Skills in presenting scientific material and arguments clearly and correctly, in writing and orally, to a range of audiences.
Core and foundation scientific physical, biological and chemical concepts, terminology, theory, units, conventions and methods. Also as applied to and in relation to forensic analysis.
Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject and to apply such knowledge and understanding to the solution of qualitative and quantitative problems.
Ability to recognise and analyse problems and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data.
Competence in the planning, design and execution of investigations, from the problem-recognition stage through to the evaluation and appraisal of results and findings; this to include the ability to select appropriate techniques and procedures.
Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them, and to present such data in a professional environment.
Generic skills needed for students to undertake further training of a professional nature.
Communication skills, covering both written and oral communication.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, correct use of units and modes of data presentation.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
Information-technology skills such as word-processing and spreadsheet use, data-logging and storage, Internet communication, etc.
Interpersonal skills, relating to the ability to interact with other people and to engage in team-working.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working. Self-management and organisational skills with the capacity to support life-long learning.
Study skills needed for continuing professional development and professional employment.
Ability to plan and implement independent projects at BSc level.

Method of Assessment

Supervisor Mark 20%, Progress Report 10%, Presentation 20%, Project Report 50%.

Preliminary Reading

Literature as indicated by the project supervisor.

Pre-requisites

None.

Synopsis *

Here, you will undertake a lab-based research project. You will choose one of three areas: Computational Chemistry, Solid-State Chemistry or Synthetic (Organic) Chemistry. You will then independently plan and execute your experiments or simulations (computational chemistry) with guidance from an academic supervisor. The module provides framework research training.

PH500 Physics Laboratory

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	I	30 (15)	100% Coursework	Kinnear Dr T

Availability

This is not available as a wild module.

Contact Hours

Laboratory sessions (54 hours across two terms), communication skills session (1 hour), lectures (2 hours).
This module is expected to occupy 300 total study hours, including the contact hours above.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to execute and analyse critically the results of an experiment or investigation and draw valid conclusions. To evaluate the level of uncertainty in these results and compare them with expected outcomes, theoretical predictions or with published data; thereby to evaluate the significance of their results in this context.
An ability to use mathematical techniques and analysis to model physical behaviour.
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
An ability to present and interpret information graphically.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
A familiarity with laboratory apparatus and techniques, including relevant aspects of Health & Safety.
The systematic and reliable recording of experimental data.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework 100%, including laboratory reports and communications exercise.

Preliminary Reading

Core Text:
Kirkup L., Experimental Methods (John Wiley and Sons, 1994, ISBN 0471335797, paperback)
Recommended:
Taylor J.R., An Introduction to Error Analysis.

Pre-requisites

None.

Synopsis *

SYLLABUS
Most practicing physicists at some point will be required to perform experiments and take measurements. This module, through a series of experiments, seeks to allow students to become familiar with some more complex apparatus and give them the opportunity to learn the art of accurate recording and analysis of data. This data has to be put in the context of the theoretical background and an estimate of the accuracy made. Keeping of an accurate, intelligible laboratory notebook is most important. Each term 3 three week experiments are performed. The additional period is allocated to some further activities to develop experimental and communications skills.

PH502 Quantum Physics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	80% Exam, 20% Coursework	Quintanilla Dr J
1	Canterbury	Whole Year	I	15 (7.5)	100% Exam	Quintanilla Dr J
1	Canterbury	Whole Year	I	15 (7.5)	64% Exam, 36% Coursework	Quintanilla Dr J
1	Canterbury	Whole Year	I	15 (7.5)	70% Exam, 30% Coursework	Quintanilla Dr J
1	Canterbury	Whole Year	I	15 (7.5)	90% Exam, 10% Coursework	Quintanilla Dr J

Availability

This not available as a wild module.

Contact Hours

Contact hours: lectures (30 hours), workshops/revision sessions (3 hours)
Total study time 150 hrs (including private study time).

Learning Outcomes

Knowledge and understanding of physical laws and principles in Quantum Physics, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems in Quantum Physics, and to make approximations necessary to obtain solutions.
An ability to solve problems in Quantum Physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Quantum Physics.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
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.

Method of Assessment

Coursework 30% including class tests;
Final (written, unseen, length 2 hours) exam 70%.

Preliminary Reading

Core Text: B. H. Bransden & C. J. Joachain, Quantum Mechanics, 2nd Edition,
Recommended Texts: Young H.D. and Freedman R.A., University Physics with Modern Physics
Rae A.I.M, Quantum Mechanics
Cassels J.M., Basic Quantum Mechanics

Pre-requisites

None.

Synopsis *

Revision of classical descriptions of matter as particles, and electromagnetic radiation as waves.
Some key experiments in the history of quantum mechanics. The concept of wave-particle duality. The wavefunction. Probability density. The Schrodinger equation. Stationary states.
Solutions of the Schrodinger equation for simple physical systems with constant potentials: Free particles. Particles in a box. Classically allowed and forbidden regions.
Reflection and transmission of particles incident onto a potential barrier. Probability flux. Tunnelling of particles.
The simple harmonic oscillator as a model for atomic vibrations.
Revision of classical descriptions of rotation. Rotation in three dimensions as a model for molecular rotation.
The Coulomb potential as a model for the hydrogen atom. The quantum numbers l, m and n. The wavefunctions of the hydrogen atom.
Physical observables represented by operators. Eigenfunctions and eigenvalues. Expectation values. Time independent perturbation theory.

PH503 Atomic Physics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	Carr Dr S (PS)
1	Canterbury	Autumn	I	15 (7.5)	70% Exam, 30% Coursework	
1	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	
1	Canterbury	Autumn	I	15 (7.5)	90% Exam, 10% Coursework	

Availability

This is not available as a wild module.

Contact Hours

32 lectures and 2 revision classes and 2 class tests. Total study hours 150, including the above.

Learning Outcomes

Knowledge and understanding of physical laws and principles in Atomic and Nuclear Physics, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems in Atomic and Nuclear Physics, and to make approximations necessary to obtain solutions.
An ability to solve problems in Atomic and Nuclear Physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Atomic and Nuclear Physics.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
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.

Method of Assessment

Examination 70%; Coursework 30% (including class tests).

Preliminary Reading

Recommended Texts:
J. Lilley, Nuclear Physics Principles and Applications, Wiley 2001
Brehm, John J, (1989) Introduction to the structure of matter: a course in modern physics, Wiley.
Kenneth S. Krane, Introductory nuclear physics, New York, 1988,
Brehm and Mullin, Introduction to the Structure of Matter. Wiley, 1989

Pre-requisites

None.

Synopsis *

Atomic Physics
Review of previous stages in the development of quantum theory with application to atomic physics; Atomic processes and the excitation of atoms; Electric dipole selection rules; atom in magnetic field; normal Zeeman effect; Stern Gerlach experiment; Spin hypothesis; Addition of orbital and spin angular moments; Lande factor; Anomalous Zeeman effect; Complex atoms; Periodic table; General Pauli principle and electron antisymmetry; Alkali atoms; ls and jj coupling; X-rays. Lamb-shift and hyperfinestructure (if time).

Nuclear Physics
Properties of nuclei: Rutherford scattering. Size, mass and binding energy, stability, spin and parity. Nuclear Forces: properties of the deuteron, magnetic dipole moment, spin-dependent forces.
Nuclear Models: Semi-empirical mass formula M(A, Z), stability, binding energy B(A, Z)/A. Shell model, magic numbers, spin-orbit interaction, shell closure effects.
Alpha and Beta decay: Energetics and stability, the positron, neutrino and anti-neutrino.
Nuclear Reactions: Q-value. Fission and fusion reactions, chain reactions and nuclear reactors, nuclear weapons, solar energy and the helium cycle.

PH504	Electromagnetism and Optics					
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Autumn	I	15 (7.5)	70% Exam, 30% Coursework	Ramos Dr S

Availability
This is not available as a wild module.

Contact Hours
Contact hours: lectures (30 hours); workshop sessions (3 hours); class tests (2 hours).
Total study hours 150 hrs.

Learning Outcomes
Knowledge and understanding of physical laws and principles in Electromagnetism and Optics, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems in Electromagnetism and Optics, and to make approximations necessary to obtain solutions.
An ability to solve problems in Electromagnetism and Optics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Electromagnetism and Optics.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
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.

Method of Assessment
Written (unseen) examination, 2 hours, 70%. Class tests: 30%.

Preliminary Reading
D.J. Griffiths, Introduction to Electrodynamics, 3rd Ed. (1999), Prentice Hall
Tipler, P. A., Physics4th Edition, W.E. Freeman
E Hecht, Optics, 2nd, Ed. (1987) Addison-Wesley.
URL: http://www.kent.ac.uk/physical-sciences-local/teaching-materials/physics.htm

Pre-requisites
PH301.

Synopsis *
SYLLABUS

Electromagnetism
Vectors: Review of Grad, Div & Curl; and other operations
Electrostatics: Coulomb's Law, electric field and potential, Gauss's Law in integral and differential form; the electric dipole, forces and torques.
Isotropic dielectrics: Polarization; Gauss's Law in dielectrics; electric displacement and susceptibility; capacitors; energy of systems of charges; energy density of an electrostatic field; stresses; boundary conditions on field vectors.
Poisson and Laplace equations.
Electrostatic images: Point charge and plane; point and sphere, line charges.
Magnetic field: Field of current element or moving charge; Div B; magnetic dipole moment, forces and torques; Ampere's circuital law.
Magnetization: Susceptibility and permeability; boundary conditions on field vectors; fields of simple circuits.
Electromagnetic induction: Lenz’s law, inductance, magnetic energy and energy density;

Optics
Field equations: Maxwell's equations; the E.M. wave equation in free space.
Irradiance: E.M. waves in complex notation.
Polarisation: mathematical description of linear, circular and elliptical states; unpolarised and partially polarised light; production of polarised light; the Jones vector.
Interference: Classes of interferometers – wavefront splitting, amplitude splitting. Basic concepts including coherence.
Diffraction: Introduction to scalar diffraction theory: diffraction at a single slit, diffraction grating.

PH507 The Multiwavelength Universe and Exoplanets

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	Froebrich Dr D
1	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	

Availability
This is not available as a wild module.

Contact Hours
33 hours of lectures.
This module is expected to occupy 150 total study hours.

Learning Outcomes
Knowledge and understanding of physical laws and principles of astronomy, astrophysics and space science, and their application to diverse areas of physics.
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.
An ability to identify relevant principles and laws when dealing with problems in astronomy, astrophysics and space science, and to make approximations necessary to obtain solutions.
An ability to solve problems in astronomy, astrophysics and space science using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour within astronomy, astrophysics and space science.
An ability to comment critically on how spacecraft are designed, their principles of operation, and their use to access and explore space, and on how telescopes (operating at various wavelengths) are designed, their principles of operation, and their use in astronomy and astrophysics research.
An ability to present and interpret astronomical, astrophysical and space science information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

Method of Assessment
Coursework (class tests) 30%;
Final (written, unseen, length 2 hours) exam 70%.

Preliminary Reading
An Introduction to Modern Astrophysics (Jul 2013), by Bradley W. Carroll and Dale A. Ostlie,
ISBN-10: 1292022930, ISBN-13: 978-1292022932

Pre-requisites
None.

Synopsis *
Aims: To provide a basic but rigorous grounding in observational, computational and theoretical aspects of astrophysics to build on the descriptive course in Part I, and to consider evidence for the existence of exoplanets in other Solar Systems.

SYLLABUS:

Observing the Universe
Telescopes and detectors, and their use to make observations across the electromagnetic spectrum. Basic Definitions: Magnitudes, solid angle, intensity, flux density, absolute magnitude, parsec, distance modulus, bolometric magnitude, spectroscopic parallax, Hertzsprung-Russel diagram, Stellar Photometry: Factors affecting signal from a star. Detectors: Examples, Responsive Quantum Efficiency, CCD cameras. Filters, UBV system, Colour Index as temperature diagnostic.

Extra Solar Planets
The evidence for extrasolar planets will be presented and reviewed. The implications for the development and evolution of Solar Systems will be discussed.

Astrophysics
Basic stellar properties, stellar spectra. Formation and Evolution of stars. Stellar structure: description of stellar structure and evolution models, including star and planet formation. Stellar motions: Space velocity, proper motion, radial velocity, Local Standard of Rest, parallax. Degenerate matter: concept of degenerate pressure, properties of white dwarfs, Chandrasekhar limit, neutron stars, pulsars, Synchrotron radiation, Schwarzschild radius, black holes, stellar remnants in binary systems.

PH508 Spacecraft Design and Operations

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	Mason Prof N

Availability

This is not available as a wild module.

Contact Hours

Lectures (30 hours), workshop sessions (4 hours) and tests.
The module is expected to occupy 150 total study hours including the contact hours above.

Learning Outcomes

Knowledge and understanding of physical laws and principles, and their application to diverse areas of physics focussed on spacecraft design and operations.
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.
An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions relevant to spacecraft science.
An ability to solve problems in physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour.
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.
An ability to use mathematical techniques and analysis to model physical behaviour.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
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.

Method of Assessment

Coursework 30% including tests and homework;
Final (written, unseen, length 2 hours) exam 70%.

Preliminary Reading

Recommended texts: Fortescue, Stark and Swinerd, Spacecraft Systems Engineering, Wiley (2003) 3rd ed, [TL875, 6 copies]
Roy, Orbital Motion, Adam Hilger, [QB355] (6 copies, 3rd edition).
Other useful texts: Griffin and French, Space Vehicle Design, AIAA, [TL875].
Wertz and Larson, Space Mission Analysis and Design, 2nd ed. Kluwer [TL790]
Chetty, Satellite Technology and its Applications, TAB Books, Inc. [TL796]
Wertz, Spacecraft Attitude Determination and Control, Reidel Publishing Co. [TL3260].
Turner, Rocket and Spacecraft propulsion, pub. Praxis [TL782]

Pre-requisites

None.

Synopsis *

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.

PH512 Data Analysis Techniques in Astronomy and Planetary Science

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Spring	I	15 (7.5)	100% Coursework	Lowry Prof S
1	Canterbury	Spring	I	15 (7.5)	100% Coursework	

Availability

This is not available as a wild module.

Contact Hours

36 contact hours including console sessions.
This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

Knowledge and understanding of aspects of the theory and practice of astronomy, and of those aspects upon which astronomy depends.
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
An ability to present and interpret astronomical information graphically.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Students will become able to: use the web to access and process astronomical data available on the internet, enhance digital and astronomical images, learn how to use astronomical image processing packages, carry out searches of astronomical databases on the web, and develop familiarity with the topics covered in the course by use of computer exercises to illustrate them.
Develop key skills for employment, learning to access data, the internet and data libraries, and development of practical skills in data collection and processing. The course is also aimed in part at promoting independent thinking when handling practical problems with astronomy data.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines.

Method of Assessment

100% coursework including weekly console exercises and various assignments.

Preliminary Reading

The Handbook of Astronomical Image Processing (http://www.willbell.com/aip/index.htm)
(Copies will be provided for in-lab use during course.)

Pre-requisites

None.

Synopsis *

SYLLABUS:

This module focuses on the use of data processing and analysis techniques as applied to astronomical data from telescopes. Students will learn how telescopes and CCD cameras work, to process astronomical images and spectra and apply a range of data analysis techniques using multiple software packages. Students will also engage in the scientific interpretation of images and spectra of astronomical objects.

Use of Virtual Observatories for accessing astronomical databases and applying analysis tools to the data files retrieved (with particular emphasis on the Aladdin system); astronomical image formats.
Astrometry: Measuring coordinates of celestial objects from images.
Photometry: Determining magnitudes of variable stars and/or solar system bodies.
Spectroscopy: Determining spectral properties of variable stars and/or solar system bodies.
Image Analysis and Enhancement with AIP: Quantifying digital imagery in more detail than Aladdin, and applying a range of techniques (primarily through the use of image operators and convolution kernels).

PH513 Medical Physics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	Podoleanu Prof A

Availability

This is not available as a wild module.

Contact Hours

Lectures (30 hours); workshop sessions (3 hours).
This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

Knowledge and understanding of physical laws and principles, and their applications in medical physics.
Knowledge and understanding of ionising radiations, with special reference to adverse health effects, to principles relating to radiation dose, and to measures necessary to protect people from the effects of ionising radiations.
Knowledge of medical imaging principles, techniques and applications using X-rays, radionuclides, ultrasound and optical radiation.
Knowledge of therapeutic principles using unsealed sources of radiation in vivo and external radiation sources.
An ability to identify relevant principles and laws when dealing with problems involving measurements or tasks medical physics, with the ability to make assumptions or approximations in order to obtain solutions.
An ability to solve problems in medical physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour.
An ability to present and interpret information graphically within a medical physics context.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems of applications of physics laws to health sciences, 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.
Analytical skills – associated with the need to pay attention to detail, to construct logical arguments and to use technical language correctly and to develop an ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly.

Method of Assessment

Written (unseen) examination - 2 hours: 70%; Class tests: 30%.

Preliminary Reading

Physics for medical imaging, R.F. Farr and P.J. Allisy-Roberts; with contributions from J. Weir, London: Saunders,1998 (repr. 2006), ID: 705044; R 895;

Hendee, William R., Medical imaging physics, William R. Hendee, E. Russell Ritenour, 4th ed., New York : Wiley-Liss, 2002, ID: 633023, q RC 78.7.D53;

Physics in nuclear medicine, Simon R. Cherry, James A. Sorenson, Michael E. Phelps., 3rd ed, Philadelphia, Pa: Saunders, c2003, ID 690435, R 895;

A practical approach to medical image processing [with cd-rom] / Elizabeth Berry, New York; London: Taylor & Francis, 2008, Series in medical physics and biomedical engineering, ID 723882, R 857.O6;

Confocal microscopy, edited by T. Wilson, London : Academic Press,1990. ID 8092, QH 224;

Handbook of biological confocal microscopy/edited by James B. Pawley, New York; London : Plenum Press, 1990, Based on papers given at the Confocal Microscopy Workshop held at the Electron Microscopy Society of America Meeting, August 8-9, 1989, in San Antonio, Texas, ID 308784, qQH 224;

Handbook of optical coherence tomography, edited by Brett E. Bouma, Guillermo J. Tearney, New York : Marcel Dekker, 2002, ID 649237, R 857.O6;

Optical coherence tomography, technology and applications, Wolfgang Drexler, James G. Fujimoto, (eds.), Berlin; London: Springer, c2008, Biological and medical physics, biomedical engineering, ID 737786, E-Book

Pre-requisites

PH301, PH504

Synopsis *

The aim of the module in Medical Physics is to provide a primer into this important physics specialisation. The range of subjects covered is intended to give a balanced introduction to Medical Physics, with emphasis on the core principles of medical imaging, radiation therapy and radiation safety. A small number of lectures is also allocated to the growing field of optical techniques. The module involves several contributions from the Department of Medical Physics at the Kent and Canterbury Hospital.

SYLLABUS:

Radiation protection (radiology, generic); Radiation hazards and dosimetry, radiation protection science and standards, doses and risks in radiology; Radiology; (Fundamental radiological science, general radiology, fluoroscopy and special procedures); Mammography (Imaging techniques and applications to health screening); Computed Tomography (Principles, system design and physical assessment); Diagnostic ultrasound (Pulse echo principles, ultrasound imaging, Doppler techniques); Tissue optics (Absorption, scattering of light in the tissue); The eye (The eye as an optical instrument); Confocal Microscopy (Principles and resolutions); Optical Coherence Tomography (OCT) and applications; Nuclear Medicine (Radionuclide production, radiochemistry, imaging techniques, radiation detectors); In vitro techniques (Radiation counting techniques and applications); Positron Emission Tomography (Principles, imaging and clinical applications); Radiation therapies (Fundamentals of beam therapy, brachytherapy, and 131I thyroid therapy); Radiation Protection (unsealed sources); Dose from in-vivo radionuclides, contamination, safety considerations.

PH520 Physics Laboratory A

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Autumn	I	15 (7.5)	100% Coursework	Kinnear Dr T

Availability

This is not available as a wild module.

Contact Hours

Contact hours: laboratory sessions (27 hours), communication skills session (1 hour), lectures (2 hours).
This module is expected to occupy 150 total study hours, including the aforementioned contact hours.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to execute and analyse critically the results of an experiment or investigation and draw valid conclusions. To evaluate the level of uncertainty in these results and compare them with expected outcomes, theoretical predictions or with published data; thereby to evaluate the significance of their results in this context.
An ability to use mathematical techniques and analysis to model physical behaviour.
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
An ability to present and interpret information graphically.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
A familiarity with laboratory apparatus and techniques, including relevant aspects of Health & Safety.
The systematic and reliable recording of experimental data.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework 100% including laboratory reports and communications exercise.

Preliminary Reading

Core Text:
Kirkup L., Experimental Methods (John Wiley and Sons, 1994, ISBN 0471335797, paperback)
Recommended:
Taylor J.R., An Introduction to Error Analysis

Pre-requisites

None.

Synopsis *

SYLLABUS:
Most practicing physicists at some point will be required to perform experiments and take measurements. This module, through a series of experiments, seeks to allow students to become familiar with some more complex apparatus and give them the opportunity to learn the art of accurate recording and analysis of data. This data has to be put in the context of the theoretical background and an estimate of the accuracy made. Keeping of an accurate, intelligible laboratory notebook is most important. Three 3 week experiments are performed. The remaining period is allocated to some additional activities to develop communication skills.

PH588 Mathematical Techniques for Physical Sciences

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Autumn	I	15 (7.5)	70% Exam, 30% Coursework	Pugh Dr E

Availability

This is not available as a wild module.

Contact Hours

Contact hours: 34 lectures, 10 workshops.

Total study hours, including private study: 150.

Learning Outcomes

An ability to solve problems in physics using appropriate mathematical tools.

An ability to present and interpret information graphically.

An ability to make use of appropriate texts, or other learning resources as part of managing their own learning.

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.

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.

Method of Assessment

30% coursework including class tests; 70% final exam.

Preliminary Reading

M Boas Mathematical Methods in the Physical Sciences (3rd ed., Wiley, 2005) ISBN: 978-0-471-36580-8

Pre-requisites

PH311 and PH312

Synopsis *

Most physically interesting problems are governed by ordinary, or partial differential equations. It is examples of such equations that provide the motivation for the material covered in this module, and there is a strong emphasis on physical applications throughout. The aim of the module is to provide a firm grounding in mathematical methods: both for solving differential equations and, through the study of special functions and asymptotic analysis, to determine the properties of solutions. The following topics will be covered: Ordinary differential equations: method of Frobenius, general linear second order differential equation. Special functions: Bessel, Legendre, Hermite, Laguerre and Chebyshev functions, orthogonal functions, gamma function, applications of special functions. Partial differential equations; linear second order partial differential equations; Laplace equation, diffusion equation, wave equation, Schrödinger’s equation; Method of separation of variables. Fourier series: application to the solution of partial differential equations. Fourier Transforms: Basic properties and Parseval’s theorem.

PH600 Physics Project

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	100% Project	

Availability

This is not available as a wild module.

Contact Hours

15 laboratory days.
This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions for a project.
An ability to execute and analyse critically the results of an experiment or investigation and draw valid conclusions. To evaluate the level of uncertainty in these results and compare them with expected outcomes, theoretical predictions or with published data; thereby to evaluate the significance of their results in this context.
An ability to use mathematical techniques and analysis to model physical behaviour.
An ability to plan an experiment or investigation under supervision and to understand the significance of error analysis.
A working knowledge of a variety of experimental, mathematical and/or computational techniques applicable to current research within physics.
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
An ability to present and interpret information graphically within a physics project.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
A familiarity with laboratory apparatus and techniques, including relevant aspects of Health & Safety.
The systematic and reliable recording of experimental data.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
C&IT skills which show fluency at the level and range needed for project work such as familiarity with a programming language, simulation software or the use of mathematical packages for manipulation and numerical solution of equations.
An ability to communicate complex scientific ideas, the conclusion of an experiment, investigation or project concisely, accurately and informatively.
Experimental skills showing the competent use of specialised equipment, the ability to identify appropriate pieces of equipment and to master new techniques and equipment.
An ability to make use of research articles and other primary sources within a project.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Preliminary Reading

Appropriate background reading will depend on the topic of the project and will be suggested by individual project supervisors.

Pre-requisites

None.

Restrictions

School of Physical Sciences
Procedures for Projects Involving Human Participation

It is a University requirement that any final year project undergraduate, postgraduate or staff research project involving human participants should be subject to a procedure to determine whether ethics approval is needed. The procedure employed by SPS and the Faculty of Science are described here:
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html

Undergraduate projects PH600, PH603, PS620, CH620, PS720, PS740 and PH700
Each project proposal collected from academics will include an ethics approval checklist designed to determine if ethical approval is required from the faculty i.e. does the project involve human participants. It is the responsibility of convenors to ask supervisors to fill in these checklists with students. If the answer to any of the questions on the checklist is yes please see below;

The following text will be introduced into the information pack or the handbooks of the module:

“Before you commence any work, it is important that the ethics of that work be considered; for example, taking fingerprints or collecting images of faces of your colleagues etc. Your supervisor will discuss any ethics issues with you and you should keep a copy of the documentation”

For projects involving human participants other than those conducting the project itself, students and their supervisors are required to read, note and act upon the guidelines available at
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html to obtain approval from the Sciences Research Ethics (Human Participation) Advisory Group.

Further information on Ethics can be obtained from Dr Donna Arnold, SPS representative on the Sciences Research Ethics Advisory Group.

Synopsis *

Aims:
To provide either
i) experimental or theoretical projects to give an introduction to scientific research procedures, or
ii) experience of the process of critical scientific review, or
iii) experience of the development of teaching or Public Understanding of Science material.
To deepen knowledge in a specialised field and be able to communicate that knowledge orally and in writing.

A choice of projects will be made available at the start of the Autumn term, to include such activities as experimental measurement and observation, the analysis of scientific information, the design and construction of electronic devices, the implementation and development of computational methods, the review of topics of current scientific interest, and the development and evaluation of new teaching aids.

PH602 Physics Problem Solving

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Autumn	H	15 (7.5)	80% Exam, 20% Coursework	Mountjoy Dr G
1	Canterbury	Autumn	H	15 (7.5)	60% Exam, 40% Coursework	Mountjoy Dr G

Availability

This is not available as a wild module.

Contact Hours

20 workshop classes. These include discussion and presentation of a variety of problems and their solution and guidance on a mini-project which forms part of the syllabus. This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with physics problems, and to make approximations necessary to obtain solutions.
An ability to solve problems in physics using appropriate mathematical tools.
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information for problem solving.
An ability to present and interpret information graphically to solve problems.
An ability to communicate scientific information about problem solving, in particular to produce clear and accurate scientific reports.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines.

Method of Assessment

Coursework 40% including class tests and mini-project;
Final (written, unseen, length 3 hours) examination 60%.

Preliminary Reading

Oman and Oman, Physics for the Utterly Confused, McGraw Hill [QC23]

3000 Solved Problems in physics, Alvin Halpern (ISBN 978-0-07-176346-2

Pre-requisites

None.

Synopsis *

Aims: After taking the classes students should be more fluent and adept at solving and discussing general problems in Physics (and its related disciplines of mathematics and engineering)

There is no formal curriculum for this course which uses and demands only physical and mathematical concepts with which the students at this level are already familiar. Instruction is given in:
Systematic and effective problem formulation
Approximation and simplification methods as they pertain to allowing viable solution methods.

Problems are presented and solutions discussed in topics spanning the entire undergraduate physics curriculum (Mechanics and statics, thermodynamics, electricity and magnetism, optics, wave mechanics, relativity etc)
Problems are also discussed that primarily involve the application of formal logic and reasoning, simple probability, statistics, estimation and linear mathematics.

PH603 Physics Group Project

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	100% Project	
1	Canterbury	Spring	H	15 (7.5)	100% Project	Mason Dr V

Availability

This is not available as a wild module.

Contact Hours

Workshops (6h) – provide the opportunity to discuss and understand the nature and the requirements of a group project;
Lecture (1h) – to agree an outline of what is expected and required in the context of the project presentation;
Presentation and feedback (~8h);
Personal and ICT-based support for project managers.

Total study hours including Intra-group project planning and implementation meetings and private study: 150 hours.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to present and interpret information graphically.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework 100%
The assessment will be based on:
the final report (50%, including prescribed appendices)
the presentation (30%)
the supplementary poster (10%)
and an element of intra-group peer review (10%)
The majority of the marks are awarded on a group basis (i.e. all members of the group receive the same mark) but some adjustments on a 'zero sum' principle may be made to individual marks on the basis of student group and supervisor/convenor feedback regarding relative contributions. The exception to this is the 10% set aside for intra-group peer assessment; this is moderated by the supervisor/convenor. Each group is also given the opportunity to assess the talks presented by the other groups; this exposure to peer assessment is regarded as an integral element of the overall module training.

Preliminary Reading

None - as this will depend entirely on the research needed to conduct the individual projects.

Pre-requisites

None.

Restrictions

School of Physical Sciences
Procedures for Projects Involving Human Participation

It is a University requirement that any final year project undergraduate, postgraduate or staff research project involving human participants should be subject to a procedure to determine whether ethics approval is needed. The procedure employed by SPS and the Faculty of Science are described here:
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html

Undergraduate projects PH600, PH603, PS620, CH620, PS720, PS740 and PH700
Each project proposal collected from academics will include an ethics approval checklist designed to determine if ethical approval is required from the faculty i.e. does the project involve human participants. It is the responsibility of convenors to ask supervisors to fill in these checklists with students. If the answer to any of the questions on the checklist is yes please see below;

The following text will be introduced into the information pack or the handbooks of the module:

“Before you commence any work, it is important that the ethics of that work be considered; for example, taking fingerprints or collecting images of faces of your colleagues etc. Your supervisor will discuss any ethics issues with you and you should keep a copy of the documentation”

For projects involving human participants other than those conducting the project itself, students and their supervisors are required to read, note and act upon the guidelines available at
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html to obtain approval from the Sciences Research Ethics (Human Participation) Advisory Group.

Further information on Ethics can be obtained from Dr Donna Arnold, SPS representative on the Sciences Research Ethics Advisory Group.

Synopsis *

The introductory workshops cover the general objectives of the module and a presentation of the specific topics available in the current year (students are explicitly encouraged to offer alternate topics provided they are able to secure the agreement of the module convenor). Additional workshops provide opportunities to discuss and share ideas, and to introduce what is needed within a successful presentation (the presentations are filmed, and the resulting DVD used for detailed feedback and for other purposes provided that the informed written consent of all group members is forthcoming). There is a distinct ‘role play’ element to the conduct of the module. Students may be given the opportunity to define their own groupings provided that there is overall agreement within the peer group, but the convenor will retain the right to define both the overall parameters (e.g. the number of students to be in each group) and the final assignment of students into groups if that proves to be necessary. Students then make a choice of topic and elect their group project manager. The groups arrange their own regular meetings, which will be minuted; the supervisor may be present at these sessions. The group will produce a word-processed report on the work undertaken; it will also present the work in appropriate ‘public’ forms (a poster and a talk). The report will include a statement on the group’s project methodology, presented in the context of their initial draft work plan and tasks assignment, as well as a statement describing the individual contributions to the group’s aims and objectives.
The project themes vary widely depending on student preferences/interests, but for example could fall in one of the following general categories:
o linked specifically to the goals of a suitable industrial partner;
o off-campus interactions, such as working with a school physics group or small business in the local area;
o the production of an instruction booklet, teaching aid or video aimed at a pre-define audience;
o a design project for a piece of instrumentation or a computational code;
o a survey or analysis of a physics-centred contemporary issue of scientific, social, political or ethical interest or concern;
o the input of physics to interdisciplinary issues such as those associated with environmental or conservation science.

PH604 Relativity Optics and Maxwell's Equations

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Autumn	H	15 (7.5)	70% Exam, 30% Coursework	Bradu Dr A

Availability

This is not available as a wild module.

Contact Hours

Lectures (30 hours), including class tests.
In addition, 120 hours of directed reading, problem solving and self-study are required.
Total number of study hours 150 hrs.

Learning Outcomes

Knowledge and understanding of electromagnetic and relativistic laws and principles, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems in electromagnetism and relativity, and to make approximations necessary to obtain solutions.
An ability to solve problems in electromagnetism and relativity using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in electromagnetism and relativity.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
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.

Method of Assessment

Coursework 30% including class tests;
Final (written, unseen, length 2 hours) exam 70%.

Preliminary Reading

Core Texts:
D.J. Griffiths, Introduction to Electrodynamics, 3rd Ed. (1999), Prentice Hall
E. Hecht, Optics 3rd Edn., Addison Wesley, [QC375.2]
J. Wilson and J.F.B. Hawks, Optoelectronics: An Introduction, Prentice-Hall International, 1983.[QC 447]
A.Yariv, Optical electronics, Holt-Saunders International, 1985. [QC 447]
G. Barton, Introduction to the Relativity Principle, J. Wiley & Sons, 1999.
URL: http://www.kent.ac.uk/physical-sciences-local/teaching-materials/physics.htm

Pre-requisites

PH301, PH504

Synopsis *

Special Relativity: Limits of Newtonian Mechanics, Inertial frames of reference, the Galilean and Lorentz transformations, time dilation and length contraction, invariant quantities under Lorentz transformation, energy momentum 4-vector
Maxwell's equations: operators of vector calculus, Gauss law of electrostatics and magnetostatics, Faraday's law and Ampere's law, physical meanings and integral and differential forms, dielectrics, the wave equation and solutions, Poynting vector, the Fresnel relations, transmission and reflection at dielectric boundaries.
Modern Optics: Resonant cavities and the laser, optical modes, Polarisation and Jones vector formulation.

PH605 Thermal and Statistical Physics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	H	15 (7.5)	70% Exam, 30% Coursework	Ramos Dr S

Availability

This is not available as a wild module.

Contact Hours

Lectures (30 hours), revision sessions (2 hours)
Total study time 150 hrs (including private study time).

Learning Outcomes

Knowledge and understanding of physical laws and principles in Thermal and Statistical Physics, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems in Thermal and Statistical Physics, and to make approximations necessary to obtain solutions.
An ability to solve problems in Thermal and Statistical Physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Thermal and Statistical Physics.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
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.

Method of Assessment

Coursework 30% including class tests;
Final exam 70%.

Preliminary Reading

Thermal physics - Baierlein, Ralph
Quantum mechanics - F. Mandl
Statistical physics - A. M. Guenault

Pre-requisites

PH311, PH312, PH321, PH323, PH502, PH503.

Synopsis *

1. Thermodynamics
Review of zeroth, first, second laws. Quasistatic processes. Functions of state. Extensive and intensive properties. Exact and inexact differentials. Concept of entropy. Heat capacities. Thermodynamic potentials: internal energy, enthalpy, Helmholtz and Gibbs functions. The Maxwell relations. Concept of chemical potential. Applications to simple systems. Joule free expansion. Joule-Kelvin effect. Equilibrium conditions. Phase equilibria, Clausius-Clapeyron equation. The third law of thermodynamics and its consequences – inaccessibility of the absolute zero.

2. Statistical Concepts and Statistical Basis of Thermodynamics
Basic statistical concepts. Microscopic and macroscopic descriptions of thermodynamic systems. Statistical basis of Thermodynamics. Boltzmann entropy formula. Temperature and pressure. Statistical properties of molecules in a gas. Basic concepts of probability and probability distributions. Counting the number of ways to place objects in boxes. Distinguishable and indistinguishable objects. Stirling approximation(s). Schottkly defect, Spin 1/2 systems. System of harmonic oscillators. Gibbsian Ensembles. Canonical Ensemble. Gibbs entropy formula. Boltzmann distribution. Partition function. Semi-classical approach. Partition function of a single particle. Partition function of N non-interacting particles. Helmholtz free energy. Pauli paramagnetism. Semi Classical Perfect Gas. Equation of state. Entropy of a monatomic gas, Sackur-Tetrode equation. Density of states. Maxwell velocity distribution. Equipartition of Energy. Heat capacities. Grand Canonical Ensemble.

3. Quantum Statistics
Classical and Quantum Counting of Microstates. Average occupation numbers: Fermi Dirac and Bose Einstein statistics. The Classical Limit. Black Body radiation and perfect photon gas. Planck’s law. Einstein theory of solids. Debye theory of solids.

PH606		Solid State Physics				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	H	15 (7.5)	70% Exam, 30% Coursework	Pugh Dr E

Availability

This is not available as a wild module.

Contact Hours

27 hours lectures and workshop/revision sessions.
This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

Knowledge and understanding of physical laws and principles in Solid State Physics, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems in Solid State Physics, and to make approximations necessary to obtain solutions.
An ability to solve problems in Solid State Physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Solid State Physics.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
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.

Method of Assessment

Examination 70%, Coursework 30% (including class tests and/or Moodle tests).

Preliminary Reading

Recommended Text:
Hook & Hall, Solid State Physics, Wiley [QC176]
Additional texts:
Kittel, Solid State Physics (7th Ed), Wiley, 1996 [QC176]
Ashcroft & Mermin, Solid State Physics, Holt-Saunders [QC176]

Pre-requisites

PH311, PH312, PH321, PH323 and PH502.

Synopsis *

To provide an introduction to solid state physics. To provide foundations for the further study of materials and condensed matter, and details of solid state electronic and opto-electronic devices.
Structure
Interaction potential for atoms and ions. Definitions, crystal types. Miller indices. reciprocal lattice. Diffraction methods.
Dynamics of Vibrations
Lattice dynamics, phonon dispersion curves, experimental techniques.
Electrons in k-space: metals
Free electron theory of metals. Density of states. Fermi-Dirac distribution. Band theory of solids - Bloch's theorem. Distinction between metals and insulators. electrical conductivity according to classical and quantum theory. Hall effect.
Semiconductors
Band structure of ideal semiconductor. Density of states and electronic/hole densities in conduction/valence band. Intrinsic carrier density. Doped semiconductors..
Magnetism
Definitions of dia, para, ferromagnetism. magnetic moments. General treatment of paramagnetism, Curie's law. Introduction to ferromagnetism.

PH607 Stars, Galaxies and the Universe

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	H	15 (7.5)	70% Exam, 30% Coursework	Smith Prof M (PS)

Availability

This is not available as a wild module.

Contact Hours

26 lectures + 2 workshops. This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

Knowledge and understanding of physical laws and principles of astrophysics, and their application to diverse areas of physics.
An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to solve problems in physics involving stars and galaxies using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour of stars and galaxies and the universe.
An ability to present and interpret information about stars and galaxies graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources about astrophysics as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
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.

Method of Assessment

Coursework assessment 30%, including class tests; Exam (Length 2 hours) 70%.

Preliminary Reading

Recommended Texts:
Carroll & Ostlie, Modern Astrophysics, Addison Wesley
Background reading:
Bohm-Vitense, Volume 3; Stellar Structure and Evolution, Cambridge University Press
Taylor, The stars: Their structure and Evolution, Cambridge University Press
Berry, Principles of Cosmology and Gravitation, Adam Hilger
Roos, Introduction to Cosmology, Wiley

Pre-requisites

None.

Synopsis *

Aims: To provide, in combination with PH507, a balanced and rigorous course in Astrophysics for B.Sc. Physics with Astrophysics students, while forming a basis of the more extensive M.Phys. modules.

SYLLABUS
Physics of Stars
Review of hydrostatic and thermal equilibrium, use to calculate stellar properties. Virial theorem and timescales. Radiative equilibrium, radiation and conduction, energy sources. Fission and fusion. Nucleosynthesis: PPI, PPII, PPIII chains; CNO cycle, Triple-alpha process; elemental abundances; Solar neutrino problem. Post main sequence evolution. Convection; conditions for convective instability. Convective vs radiative energy transport for stars of different mass. Stellar structure equations and description of techniques for solutions. Formation and properties of binary stars.
Galaxies
Our galaxy. Hubble classification of galaxies. Luminosity functions. Distribution of galaxies in space. Mass and dynamics of galaxies. Interpretation of spiral and elliptical galaxies. Dark Matter. Active galaxies, quasars; observational properties.
General Relativity and Cosmology
Inadequacy of Newton's Laws of Gravitation, principle of Equivalence, non-Euclidian geometry. Curved surfaces. Schwarzschild solution; Gravitational redshift, the bending of light and gravitational lenses; black holes. Brief survey of the universe. Robertson-Walker metric, field equations for cosmological and critical density. Friedmann models. The early universe. Dark Energy.

PH608 The Sun, The Earth and Mars

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Autumn	H	15 (7.5)	70% Exam, 30% Coursework	Urquhart Dr J
1	Canterbury	Autumn	H	15 (7.5)	90% Exam, 10% Coursework	Urquhart Dr J

1	Canterbury	Spring	H	15 (7.5)	70% Exam, 30% Coursework

Availability

This is not available as a wild module.

Contact Hours

Lectures (30 hours); workshops/revision sessions (3 hours).
Total study time 150 hrs (including private study time).

Learning Outcomes

Knowledge and understanding of physical laws and principles in Solar System Science, and their application to diverse areas of physics.
Aspects of the theory and practice of astronomy, astrophysics and space science, and of those aspects upon which astronomy, astrophysics and space science depends.
An ability to identify relevant principles and laws when dealing with problems in Solar System Science, and to make approximations necessary to obtain solutions.
An ability to solve problems in Solar System Science using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Solar System Science.
An ability to comment critically on how spacecraft are designed, their principles of operation, and their use to access and explore space, and on how telescopes (operating at various wavelengths) are designed, their principles of operation, and their use in astronomy and astrophysics research.
An ability to present and interpret astronomy, astrophysics and space science information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
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.

Method of Assessment

Coursework (class tests) 30%;
Final (written, unseen, length 2 hours) exam 70%.

Preliminary Reading

Physical Principles of Remote Sensing; Rees, Gareth 2001
Terrestrial Physics; 2013
The Scientific Exploration of Mars; Taylor, F. W.2010
Recommended:
Physics of the Sun: A First Course; Mullan, Dermott J. 2010
Mars: A Warmer, Wetter Planet; Kargel, J. S.2004
Introduction to the physics and techniques of remote sensing, Elachi, 2nd Edition, 2006

Pre-requisites

PH304, PH311, PH312, PH321, PH323, PH503, PH508.

Synopsis *

Aims:
To understand the nature of the solar activities, emissions and its properties, and its effects on the Earth's atmosphere and the near-Earth space within which spacecraft operate.
To have a familiarity with the modes of operation of remote sensing and communications satellites, understanding their function and how their instruments work
To be familiar with the current space missions to Mars and their impact on our understanding of that planet.

Solar Terrestrial physics
The sun: Overall structure, magnetic field and solar activities.
Interactions with Earth: plasma physics, solar wind, Earth's magnetic field.
Ionospheric physics. Terrestrial physics: Earth's energy balance, Atmosphere. Environmental effects.

Remote Sensing
Modes of operation of remote sensing satellite instruments: radio, microwave, visual and infrared instruments. Basic uses of the instruments. Digital image processing, structure of digital images, image-processing overview, information extraction. environmental applications: UV radiation and Ozone concentration, climate and weather.
Martian Science
An overview of recent and future Mars space missions and their scientific aims. Discussions of the new data concerning Mars and the changing picture of Mars that is currently emerging.

PH611 Numerical and Computational Methods

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	H	15 (7.5)	60% Exam, 40% Coursework	Gibson Dr S

Availability

This is not available as a wild module.

Contact Hours

20 hours of lectures and 12 hours of computer console sessions.

This module is expected to occupy 150 total study hours, including contact hours.

Learning Outcomes

Knowledge and understanding of:
Physical laws and principles, and their application to diverse areas of physics.

Intellectual skills:
An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to solve problems in physics using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour.
An ability to solve advanced problems in physics using appropriate mathematical tools, to translate problems into mathematical statements and apply their knowledge to obtain order of magnitude or more precise solutions as appropriate.
An ability to interpret mathematical descriptions of physical phenomena.
A working knowledge of a variety of mathematical and/or computational techniques applicable to current research within physics.

Subject-specific skills:
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, or other learning resources as part of managing their own learning.

Transferable skills:
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.
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.

Method of Assessment

40% coursework: 6 problem sheets involving handwritten and computer programming components; 60% final exam.

Preliminary Reading

C. Moler, Numerical Computing with MATLAB, Society for Industrial and Applied Mathematics, SIAM,2004 ISBN 978-0-898715-60-6

S. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, McGraw-Hill,2008. ISBN: 978-0-07-313290-7

Pre-requisites

PH302, PH311 and PH312

Synopsis *

In Stage 1 and Stage 2, students frequently apply analytical methods to physical problem solving. This module provides a foundation in numerical approximations to analytical methods – these techniques are essential for solving problems by computer. The following topics are covered: Linear equations, zeros and roots, least squares & linear regression, eigenvalues and eigenvectors, errors and finite differences, linear programming, interpolation and plotting functions, numerical integration, , numerical differentiation, solutions to ordinary differential equations using numerical methods.

PH617 Physics Project Laboratory

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	100% Coursework	Mason Dr V

Availability

This is not available as a wild module.

Contact Hours

18 laboratory days.
This module is expected to occupy 150 total study hours, including the contact hours above.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions for laboratory projects.
An ability to execute and analyse critically the results of an experiment or investigation and draw valid conclusions. To evaluate the level of uncertainty in these results and compare them with expected outcomes, theoretical predictions or with published data; thereby to evaluate the significance of their results in this context.
An ability to use mathematical techniques and analysis to model physical behaviour.
Competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
An ability to present and interpret information graphically for project reports.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
A familiarity with laboratory apparatus and techniques, including relevant aspects of Health & Safety.
The systematic and reliable recording of experimental data.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework 100% including standard laboratory reports and mini-project (extended report).

Preliminary Reading

Taylor J.R., An Introduction to Error Analysis
Silyn-Roberts, Writing for Science
Barrass, Scientists Must Write, 2nd ed

Pre-requisites

None.

Synopsis *

Aims:
To provide experience in laboratory based experimentation, data recording and analysis and drawing of conclusions.
To develop report writing skills for scientific material
To develop the ability to undertake investigations where, as part of the exercise, the goals and methods have to be defined by the investigator.
To develop skills in literature searches and reviews.

The module has two parts: Laboratory experiments and a mini-project. For half the term the students will work in pairs on a series of 3 two-week experiments. A report will be written by each student for each experiment.
Experiments include:
Solar cells
NMR
Hall effect
Gamma ray spectroscopy
X-ray diffraction
Optical spectroscopy

Mini-projects. For half the term the students will work in pairs on a mini-project. These will be more open-ended tasks than the experiments, with only brief introductions stating the topic to be investigated with an emphasis on independent learning. A report will be written by each student on their project.

PH618 Image Processing

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Autumn	H	15 (7.5)	80% Exam, 20% Coursework	
1	Canterbury	Autumn	H	15 (7.5)	60% Exam, 40% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Lectures (18 hours), console sessions (12 hours).
This module is expected to occupy 150 total study hours, including directed reading, console/computer-based exercises and mathematical and conceptual problem-solving.

Learning Outcomes

Knowledge and understanding of laws and principles of imaging processing, and their application to diverse areas of physics.
An ability to solve problems in image processing using appropriate mathematical tools.
Competent use of appropriate C&IT packages/systems for the analysis of images and the retrieval of appropriate information.
An ability to present, process and interpret information graphically.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
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.
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.

Method of Assessment

Coursework 40% including class tests;
Final exam 60%.

Preliminary Reading

Gonzalez and Woods, Digital Image Processing, Addison-Wesley, 1992, ISBN 0-201-50803-6
Fundamentals of digital image processing: a practical approach with examples in Matlab, Solomon, Chris, Breckon, Toby 2011
John C. Russ, The Image Processing Handbook, CRC Press, 1995
D. Hanselman and B. Littlefield, Mastering Matlab 7, Prentice-Hall, 2005, ISBN 0-13-243767-8

Pre-requisites

None.

Synopsis *

Introduction to Matlab
• Image representation,
• Image formation,
• Grey-scale transformation,
• Enhancement and extraction of image content,
• Fourier transforms and the frequency domain,
• Image restoration, geometrical transformations,
• Morphology and morphological transformations,
• Feature extraction,
• Segmentation.

PH700 Physics Research Project

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	M	60 (30)	100% Project	Hughes Dr M (SPS)

Availability

This is not available as a wild module.

Contact Hours

5 hours module introduction, talks guidance and feedback on talks;
40 days conducting supervisor-guided research (a minimum of 280 timetabled hours);
2 days project 'conference' (approx. 14 hours).

Total hours of study, including private study: 600 hours.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to solve problems in physics using appropriate mathematical tools.
An ability to execute and analyse critically the results of an experiment or investigation and draw valid conclusions. To evaluate the level of uncertainty in these results and compare them with expected outcomes, theoretical predictions or with published data; thereby to evaluate the significance of their results in this context.
An ability to interpret mathematical descriptions of physical phenomena.
An ability to plan an experiment or investigation under supervision and to understand the significance of error analysis.
A working knowledge of a variety of experimental, mathematical and/or computational techniques applicable to current research within physics.
An ability to present and interpret information graphically.
An ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
A familiarity with laboratory apparatus (including relevant aspects of Health & Safety), theories and techniques.
The systematic and reliable recording of experimental data or derivation of theoretical results.
An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning. C&IT skills which show fluency at the level and range needed for project work such as familiarity with a programming language, simulation software or the use of mathematical packages for manipulation and numerical solution of equations.
An ability to communicate complex scientific ideas, the conclusion of an experiment, investigation or project concisely, accurately and informatively.
Experimental skills showing the competent use of specialised equipment, the ability to identify appropriate pieces of equipment and to master new techniques and equipment.
An ability to make use of research articles and other primary sources.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature, databases, and the interaction with colleagues to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts and presenting complex information in a clear and concise manner. C&IT skills are an important element to this.
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.
Personal skills – the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Coursework 100%. Students are required both to write a formal report of the work and to present their findings as a talk, such as would be contributed to a scientific conference. The conference-style presentation is filmed, and the resulting DVD used to provide detailed feedback. The work is also subject to an oral examination. The final mark will be obtained from four separate assessments: 1) the progress, aptitude and general diligence (15%), 2) the progress report (55%), 3) an oral examination (15%) and 4) a talk (%15).

Preliminary Reading

None; appropriate background reading will be suggested by individual project supervisors

Pre-requisites

None.

Restrictions

School of Physical Sciences
Procedures for Projects Involving Human Participation

It is a University requirement that any final year project undergraduate, postgraduate or staff research project involving human participants should be subject to a procedure to determine whether ethics approval is needed. The procedure employed by SPS and the Faculty of Science are described here:
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html

Undergraduate projects PH600, PH603, PS620, CH620, PS720, PS740 and PH700
Each project proposal collected from academics will include an ethics approval checklist designed to determine if ethical approval is required from the faculty i.e. does the project involve human participants. It is the responsibility of convenors to ask supervisors to fill in these checklists with students. If the answer to any of the questions on the checklist is yes please see below;

The following text will be introduced into the information pack or the handbooks of the module:

“Before you commence any work, it is important that the ethics of that work be considered; for example, taking fingerprints or collecting images of faces of your colleagues etc. Your supervisor will discuss any ethics issues with you and you should keep a copy of the documentation”

For projects involving human participants other than those conducting the project itself, students and their supervisors are required to read, note and act upon the guidelines available at
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html to obtain approval from the Sciences Research Ethics (Human Participation) Advisory Group.

Further information on Ethics can be obtained from Dr Donna Arnold, SPS representative on the Sciences Research Ethics Advisory Group.

Synopsis *

Aims:
To provide an experience of open-ended research work.
To begin to prepare students for postgraduate work towards degrees by research or for careers in R&D in industrial or government/national laboratories.
To deepen knowledge in a specialised field and be able to communicate that knowledge orally and in writing.
Syllabus
All MPhys students undertake a laboratory, theoretical or computationally-based project related to their degree specialism. These projects may also be undertaken by Diploma students. A list of available project areas is made available during Stage 3, but may be augmented/revised at any time up to and including Week 1 of Stage 4. As far as possible, projects will be assigned on the basis of students' preferences – but this is not always possible: however, the project abstracts are regarded as 'flexible' in the sense that significant modification is possible (subject only to mutual consent between student and supervisor). The projects involve a combination of some or all of: literature search and critique, laboratory work, theoretical work, computational physics and data reduction/analysis. The majority of the projects are directly related to the research conducted in the department and are undertaken within the various SPS research teams.

PH709 Space Astronomy and Solar System Science

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Autumn	M	15 (7.5)	70% Exam, 30% Coursework	Lowry Prof S

Availability

This is not available as a wild module.

Contact Hours

30 contact hours, including: 26 hours of lectures, 2 hours of workshops, and class tests.

In addition, 120 hours of self-study are required.

Learning Outcomes

An ability to identify relevant principles and laws when dealing with problems in Space Astronomy and Solar System Science, and to make approximations necessary to obtain solutions.
An ability to solve problems in astronomy, astrophysics and space science using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour in Space Astronomy and Solar System Science.
An ability to comment critically on how spacecraft and space telescopes (operating at various wavelengths) are designed, their principles of operation, and their use in solar system exploration and astronomy & astrophysics research.
An ability to solve advanced problems in astronomy, astrophysics and space science using appropriate mathematical tools.
An ability to interpret mathematical descriptions of physical phenomena in Space Astronomy and Solar System Science.
An ability to work within the space sciences area that is well matched to the frontiers of knowledge, the science drivers that underpin government funded research and the commercial activity that provides hardware or software solutions to challenging scientific problems in these fields.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials, other primary sources or other learning resources as part of managing their own learning.
An ability to discuss coherently the origin and evolution of Solar Systems and be able to evaluate claims for evidence of Solar Systems other than our own.
Ability to identify relevant principles, make relevant approximations and solve problems using a mathematical approach.
Students should become fluent in current trends and methods as regards to space astronomy and Solar System exploration.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature and databases, to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts.
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.

Method of Assessment

Final Examination (70%);
2 class tests (15% each).

Preliminary Reading

Wertz and Larson, Space Mission Analysis and Design, 3rd Edition

Jones, Discovering the Solar System, 2nd Edition

Taylor, Solar System Evolution, 2nd Edition

Other reading:
Davies; Astronomy from Space: The Design and Operation of Orbiting Observatories, Wiley

Encrenaz, Bibring and Blanc; The Solar System, Springer

Jakosky: The Search for Life on Other Planets

Gilmour & Sephton: Introduction to Astrobiology

Carroll and Ostlie, Modern Astrophysics (2nd ed)

Pre-requisites

None.

Synopsis *

SYLLABUS:

Space Astronomy
Why use space telescopes; other platforms for non-ground-based astronomical observatories (sounding rockets, balloons, satellites); mission case study; what wavelengths benefit by being in space; measurements astronomers make in space using uv, x-ray and infra-red, and examples of some recent scientific missions.

Exploration of the Solar System
Mission types from flybys to sample returns: scientific aims and instrumentation: design requirements for a spacecraft-exploration mission; how to study planetary atmospheres and surfaces: properties of and how to explore minor bodies (e.g. asteroids and comets): current and future missions: mission case study; how space agencies liaise with the scientific community; how to perform calculations related to the orbital transfer of spacecraft.

Solar System Formation and Evolution
The composition of the Sun and planets will be placed in the context of the current understanding of the evolution of the Solar System. Topics include: Solar system formation and evolution; structure of the solar system; physical and orbital evolution of asteroids.

Extra Solar Planets
The evidence for extra Solar planets will be presented and reviewed. The implications for the development and evolution of Solar Systems will be discussed.

Life in Space
Introduction to the issue of what life is, where it may exist in the Solar System and how to look for it.

PH711 Rocketry and Human Spaceflight

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Spring	M	15 (7.5)	70% Exam, 30% Coursework	Lowry Prof S

Availability

This is not available as a wild module.

Contact Hours

30 contact hours, including lectures (26 hours), 2 workshop sessions (2 hours) and class tests.

In addition 120 hours of directed reading and self-study are required.

Learning Outcomes

Aspects of the theory and practice of space science, and of those aspects upon which space science depends in relation to rocketry and Human Space Flight (a knowledge of key physics, especially for rocketry).
An understanding of relevant fundamental laws and principles of physics, along with their application to rocketry and human spaceflight.
An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
An ability to solve problems in rocketry and human spaceflight using appropriate mathematical tools.
An ability to use mathematical techniques and analysis to model physical behaviour.
An ability to solve advanced problems in rocketry and human spaceflight using appropriate mathematical tools, to translate problems into mathematical statements and apply their knowledge to obtain order of magnitude or more precise solutions as appropriate.
An ability to interpret mathematical descriptions of physical phenomena.
An ability to present and interpret information graphically.
An ability to make use of appropriate texts, research-based materials, other primary sources or other learning resources as part of managing their own learning.
To develop an appreciation of the design, construction and testing of space vehicles and their operation.
To understand the basic physiological changes the human body is subject to in space.
To develop an appreciation of the uses of space for science and by astronaut.
Ability to identify relevant principles, discuss in an informed fashion, make relevant descriptions or approximations (mathematical or otherwise) and solve problems.
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.
Investigative skills in the context of independent investigation including the use of textbooks and other available literature and databases to extract important information.
Communication skills in the area of dealing with surprising ideas and difficult concepts, including listening carefully, reading demanding texts.
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.

Method of Assessment

Coursework (30% - includes 2 class tests at 15% each);
Final Examination (70%).

Preliminary Reading

Recommended Text:
Fortescue, Stark and Swinerd, Spacecraft Systems Engineering, 3rd ed, Wiley, 2003

Other recommended reading:
Wetz and Larson, Space Mission Analysis and Design, 3rd Edition,
Sutton, Rocket Propulsion Elements
Sidi, Spacecraft Dynamics and Control
Background reading (In addition, a fuller reading list will be distributed in the lectures):
McNamara: Into the Final frontier, pub. Harcourt
Nicogossian, Huntoon and Pool: Space Physiology and Medicine, pub Lea & Febiger
Turner: Rocket and Spacecraft Propulsion, pub. Praxis

Pre-requisites

PH508

Synopsis *

Flight Operations: Control of spacecraft from the ground, including aspects of telecommunications theory.

Propulsion and attitude control: Physics of combustion in rockets, review of classical mechanics of rotation and its application to spacecraft attitude determination and control.

Impact Damage: The mechanisms by which space vehicles are damaged by high speed impact will be discussed along with protection strategies.

Human spaceflight: A review of human spaceflight programs (past and present). Life-support systems. An introduction to some major topics in space medicine; acceleration, pressurisation, radiation, etc.

International Space Station: Status of this project/mission will be covered.

PH722 Particle and Quantum Physics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Autumn	M	15 (7.5)	70% Exam, 30% Coursework	Moller Dr G

Availability

This is not available as a wild module.

Contact Hours

28 hours of lectures.

This module is expected to occupy 150 total study hours.

Learning Outcomes

Ability to identify relevant physical principles, make mathematical descriptions or approximations and solve problems using a mathematical approach.
Familiarity with how particle physics experiments work.
Ability to discuss particle physics in the language of particles and fields.
An understanding of the formalism of quantum mechanics and the ability to cast physical problems into it.

Enhancement of problem solving abilities, particularly mathematical approaches to problem solving.
To use appropriate sources as part of directed self-learning.
Enhancement of the ability to interpret theory.
An improved ability to manipulate precise and complex ideas and to construct logical arguments.

Method of Assessment

70% final examination; 30% coursework, including class tests.

Preliminary Reading

B. R. Martin, Nuclear and Particle Physics, Wiley, (2006).

M Thomson, Modern Particle Physics, Cambridge (2013)
A Bettini, Introduction to Elementary Particle Physics (QC794.6.575)
S McMurry, Quantum Mechanics, Prentice-Hall (1993)

F Mandl, Quantum Mechanics, Wiley (1992)

Pre-requisites

PH502, PH503

Synopsis *

• Approximation Methods, perturbation theory, variational methods.
• Classical/Quantum Mechanics, measurement and the correspondence principle.
• Uncertainty Principle and Spin precession .
• Key Experiments in Modern Quantum Mechanics (Aharonov-Bohm, neutron diffractyion in a gravitational field, EPR paradox).
• Experimental methods in Particle Physics (Accelerators, targets and colliders, particle interactions with matter, detectors, the LHC).
• Feynman Diagrams, particle exchange, leptons, hadrons and quarks.
• Symmetries and Conservation Laws.
• Hadron flavours, isospin, strangeness and the quark model.
• Weak Interactions, W and Z bosons.

PH751		Research Review				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	M	15 (7.5)	100% Coursework	

Contact Hours

This module is essentially self-taught; there is no curriculum. The students will be assigned a tutor for the module who can advise them on the subject, direct them to the relevant literature and advise them on the subject as and when required. They are expected to spend a total of 150 hours on this module.

In order to write the review, a student is expected to read a minimum of 4-6 journal and review papers. The student is required to present a dissertation based on the contents of these papers.

Milestone 1: Students provide a list of potential supervisors/themes by end of Week 6. This is deliberately Week 6 since students may not be familiar with Kent research areas.

Milestone 2: By Week 8 students should be provided with the list of seminal papers to provide the fundaments for their review.

Milestone 3: Students arrange a brief discussion with their appointed tutors in Week 11.

Week 14: Students meet with Convenor for a feedback session.

Week 18: Students email Tutor and Convenor with a half-complete draft for approval and feedback.

Learning Outcomes

An appreciation of the "state of the art" in a chosen focused area of Physics.

An ability to explain complex physical arguments to an audience of experts.

An ability to make a critical analysis of specialist literature.

An understanding at the frontier of knowledge in a subject.

An ability to make a critical analysis of published scientific literature.

Enhancement of the ability to interpret theory.

An ability to present information graphically and textually at an advanced intellectual level.

An ability to explain complex physical arguments to a scientifically literate, but non-specialist audience.

An ability to produce a substantial piece of independent work.

Method of Assessment

Coursework 100%. 80% Review Article, 20% oral presentation. All learning outcomes are tested in the review article itself, while the ability to communicate to a scientifically literate, but non-specialist audience is also tested orally in the presentation.

Preliminary Reading

None; appropriate background reading will be suggested by individual project supervisors

Pre-requisites

None.

Synopsis *

In consultation with a member of staff the student will choose a topic within any branch of physics for which appropriate supervision is available and write an article on that topic that would be suitable for publication in the scientific literature as a review article.

PH752 Magnetism and Superconductivity

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	M	15 (7.5)	70% Exam, 30% Coursework	Quintanilla Dr J

Availability
This is not available as a wild module.
Contact Hours
28 hours of lectures. Voluntary examples/revision classes will also be provided.

Learning Outcomes
An understanding of the underlying physics of magnets and superconductors.
An appreciation of the rich variety of physics dependent correlated electrons.
An ability to solve problems in the science of magnetism and superconductivity.
An appreciation of the role of magnets and superconductors in devices and industry.
Enhancement of problem solving abilities, particularly mathematical approaches to problem solving.
To use appropriate sources as part of directed self-learning.
Enhancement of the ability to interpret theory.
A deeper appreciation of the connection of the role played by fundamental science in society generally.

Method of Assessment
70% final examination, 30% coursework including class tests.

Preliminary Reading
Core texts:
S. Blundell; Magnetism in Condensed Matter, Oxford University Press (2001)
J.F. Annett; Superconductivity, Superfluids and Condensates, Oxford University Press (2004)
Additional reading:
S. Elliot: The Physics and Chemistry of Solids (1998)
D.C. Mattis The theory of magnetism made simple (2004)
Tilley and Tilley; Superfluidity and Superconductivity, (1990)

Pre-requisites
PH606
Synopsis *
Introduction, electrons in solids
Superconductivity: Introduction to properties of superconductors, Thermodynamics and electrodynamics of superconductors, Type I and Type II superconductors, the flux lattice
Superconducting phase transitions
Microscopic superconductivity, correlations lengths, isotope effect, Cooper pairs, Froehlich Interaction, BCS theory.
High Tc superconductors, superfluids, liquid helium.
Magnetism, magnetometry and measuring techniques
Localised and itinerant magnetic moments, spin and orbital moments, magnetic moments in solids
Paramagnetism
Exchange interactions, direct, indirect and superexchange, Magnetic structures, ferro, ferri, antiferromagnetism
Neutron and x-ray scattering
Spin waves, magnons
Magnetic phase transitions
See also http://blogs.kent.ac.uk/strongcorrelations/teaching/superconductivity-and-magnetism

PS501		Forensic Physical Methods				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	100% Coursework	Green Mr R(PS)
1	Canterbury	Whole Year	I	15 (7.5)	50% Coursework, 50% Exam	Green Mr R(PS)

Availability

This is not available as a wild module.

Contact Hours

26 hours of lectures, coursework, 18 hours of laboratory practical sessions, 1 x 4 hour managed incident, 1 x 4 hour incident analysis.

Learning Outcomes

An understanding of the role of physical forensic methods in forensic practice.
Knowledge and critical awareness of the major physical forensic methods.
An understanding of emerging developments in forensic science.
The ability to assess, manage, and investigate a range of incident scenes.
The ability to recover, preserve, package and document evidential samples from a range of incident scenes to professional standards.
Develop a broad and balanced understanding of the key areas of science and law that underpins forensic practice and methodology.
Develop a core understanding of the science and scientific methods underpinning forensic investigation and recovery of evidence.
Develop the ability to communicate complex scientific and forensic findings to a lay audience in written form.
Develop problem solving, information retrieval and handling, and numeracy skills.
Develop team working and time management skills, and skills relevant to further study.

Method of Assessment

Coursework: 100%
- Laboratory work: 20%
- Managed incident : 30%
- Incident management and analysis with incident report and statement: 50%

Preliminary Reading

RECOMMENDED READING:

Criminalistics (An Introduction to Forensic Science), Richard Saferstein, Prentice Hall. ISBN 0-13-013827-4
Crime Scene to Court, Edited by Peter White, ISBN 0-85404-539-2
Forensic Science (2nd Edition), Andrew and Julie Jackson, ISBN: 978-0-13-199880-3

Pre-requisites

None.

Synopsis *

Evidential practice and law in relation to location, recovery, preservation, and interpretation of a wide range of forensic samples.
Statement and report writing, and witness interview to evidential standard.
Incident assessment and management in a wide variety of forensic environments.
Location, recovery and preservation of a range of forensic samples using our new crime scene house and garden, including: Fingerprints, DNA, fibres, trace samples, blood distribution patterns, gunshot residues, tool marks and impressions, foot shoe and tyre prints, sexual offence samples.
Incident mapping and photography.
Document and forgery analysis.

PS502 Forensic Archaeology

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	Green Prof M

Availability
This is not available as a wild module.
Contact Hours
22 hours of lectures.

Learning Outcomes
Knowledge of the principle areas of forensic archaeology including dating, detection and osteology.

Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to forensic archaeology.

Ability to apply such knowledge and understanding to the solution of problems.

Problem-solving skills, relating to qualitative and quantitative information.

Numeracy and computational skills.
Method of Assessment
Written examination 70%; Coursework 30%.

Preliminary Reading
Zumdahl, Chemical Principles

Byers, S. 2005. Introduction to forensic anthropology. London : Pearson/Allyn and Bacon.

White, T.D. 2000. Human Osteology. San Diego, California, London : Academic Press Inc.

J. Hunter & M. Cox, 2005. Forensic Archaeology. Routledge, London, 2005 - chapter 3

E.W. Killam. 2004. The Detection of Human Remains. Charles Thomas, Springfield - chapters 5-8

T.L. Dupras, J.J. Schultz, S.M. Wheeler & L.J. Williams. 2006. Forensic Recovery of Human Remains.

Taylor and Francis, Boca Raton - chapter 4

A. Clark. 1990. Seeing Beneath the Soil. Batsford, London.

White, T.D., Black, M.T., Folkens, P.A.2011. Human Osteology. San Diego, California, London : Academic Press Inc.

Pre-requisites
None.

Synopsis *
Dating : Radioactive decay and detection of radiation, radiocarbon dating and related methods, accelerator mass spectrometry, uranium series dating, potassium-argon dating, radioactive tracers, isotope dilution, neutron activation, stable isotope techniques with forensic applications, electron spin resonance spectroscopy, thermoluminescence dating and thermal history, Lindow Man, detection of irradiated food.

Detection : Magnetometry, metal detectors, resistivity surveys, ground penetrating radar, aerial photography, and remote sensing.

Osteology : The study of human osteology is fundamental to the discipline of forensic anthropology. This series of lectures begins by examining the structure, growth, and function of bones and teeth. Methods of skeletal analysis in forensic anthropology are then examined, including age, sex, stature, trauma, disease, and race. Applications in biological anthropology will also be reviewed. This section of the course will include a laboratory practical.

PS511 Digital Forensics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	Gibson Dr S

Availability

This is not available as a wild module.

Contact Hours

20 lectures and 10 x 2hr laboratory classes.

Learning Outcomes

Knowledge and understanding of: Association of Chief Police Officer’s guidelines for ‘National Working Practices in Facial Imaging’
The main facial identification techniques used in criminal investigations
Practical experience of using facial composite software
Methods used in digital image forensics and their implementation in the computer software
Aspects of digital forensics including: legislation to enforce appropriate computer use; cryptography for secret communication; network forensics and methods used to hide data on computer hardware and methods for retrieving it.
To use forensic software in relation to mock criminal investigations
To enhance skills in a laboratory environment
Ability to demonstrate knowledge and understanding of the essential facts, and concepts, relating to the subject area

Method of Assessment

Examination - 60%; coursework - 40%

Preliminary Reading

Optional Reading:

Digital Image Processing using MATLAB, Gonzalez Woods & Eddins, Pearson Prentice Hall, 2004.

Fundamentals of digital image processing: a practical approach with examples in Matlab - Solomon, Chris, Breckon, Toby 2011.

Forensic Computer: A Practitioner's Guide, T Sammes & J Jenkinson, Springer,2007.

Handbook of Computer Crime Investigation, E Casey, Academic Press, 2002.

Craniofacial Identification, C Wilkinson & C Ryan, Cambridge, 2012.

Investigation Digital Crime, R Bryant, John WIley & Sons, 2008.

Pre-requisites

Successful completion of Stage 1 of a Forensic Science degree programme or equivalent experience.

Synopsis *

Facial Identification
Facial reconstruction, facial composites, description by witness – cognitive interview - Turnbull’s rules (R v Turnbull, 1976), identity parades – psychology of facial identification – video identity parades, facial mapping, automated recognition technologies, age progression.

Digital Image Analysis
Image formation, image storage, image distortion, image restoration methods, the digital image in crime detection, steganography (implementation and detection).

Digital Forensics
Encryption, fallacies about hiding and destroying data, where to find data and methods for retrieving it, disk imaging, file integrity, cryptographic hashing, privacy vs need for investigation.

PS512 Numerical, Statistical and Analytical Skills

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	Shepherd Dr H
1	Canterbury	Whole Year	I	15 (7.5)	50% Coursework, 50% Exam	Shepherd Dr H

Availability

This is not available as a wild module.

Contact Hours

24 hours of lectures, 5 hours of examples classes, 18 hours of laboratory sessions.

Learning Outcomes

Knowledge and understanding of:
Core and foundation scientific physical and chemical concepts, terminology, theory, units, conventions, and laboratory methods in relation to forensic science and the chemical sciences.
Areas of chemistry as applied to forensic analysis.
Numeracy (including data analysis and statistics).

Intellectual skills:
Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject and to apply such knowledge and understanding to the solution of qualitative and quantitative problems.
Ability to recognise and analyse problems and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data.
Ability to recognise and implement good measurement science and practice and commonly used forensic laboratory techniques.

Subject-specific skills:
Skills in the safe handling of chemical materials, taking into account their physical and chemical properties, including any specific hazards associated with their use and to risk assess such hazards.
Skills required for the conduct of standard laboratory procedures involved in analytical work, and in the operation of standard instrumentation used in analysis and separation in forensic and chemical sciences.
Ability to interpret and explain data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them, including an assessment of limits of accuracy.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, correct use of units and modes of data presentation.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
Information-technology skills such as word-processing and spreadsheet use, data-logging and storage, Internet communication, etc.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working).
Generic skills needed for students to undertake further training of a professional nature.
Study skills needed for continuing professional development and preparation for employment.

Method of Assessment

Examination 60%; Coursework 40%

Preliminary Reading

P. Monk & L. J. Munro “Maths for Chemistry” 2nd edition (Oxford, 2010) ISBN 0199541299
S. K. Scott, “Workbooks in Chemistry – Beginning Mathematics for Chemistry” (Oxford, 1995). ISBN 0198559305
J. N. Miller and J. C. Miller, “Statistics and chemometrics for analytical chemistry”, 6th edition (Pearson Prentice Hall 2010), ISBN: 0273730428
D. Lucy “Introduction to statistics for forensic scientists”, (Wiley, 2005) ISBN 0 47 002201 9
M. R. Spiegel, “Schaum’s outline of probability and statistics” 4th edition (McGraw Hill, 2013) ISBN 9780071795579
D. Rowntree “Statistics without tears”, (Penguin, 2000) ISBN: 0 14 013632 0. It’s non-mathematical and excellent for getting a grasp of concepts.

Pre-requisites

Successful completion of Stage 1 of the Forensic Science, Forensic Chemistry, or Chemistry degree programme; or equivalent.

Synopsis *

Trace Analysis:
Trace analysis: definitions, methods and problems. Sampling, storage and contamination. Quality control. Random and systematic errors; statistical treatment of data. Accuracy and precision. Signal/noise ratio. Sensitivity and detection limits. Choice of methods for trace analysis.

Units, dimensions, exponentials and logarithms:
Decimal places and significant figures. Units and dimensions: SI units, dimensional analysis. Manipulation of exponentials and logarithms. Power laws. Exponential decay and half-life. Beer-Lambert law, Arrhenius equation, Boltzmann distribution, Gaussian functions.

Chemical Arithmetic:
Balancing chemical equations. Amount of substance, molar quantities, concentration and volumetric calculations, gravimetric analysis, gas pressures and volumes.
Equilibrium calculations, strong and weak electrolytes. pH, acid-base equilibria, buffer solutions. Solubility. Chemical kinetics: reaction rates, rate constants and orders of reaction.

Probability and Statistics:
Elementary probability, probability spaces, Venn diagrams, independence, mutual exclusion, expectation. Quantitative treatment of the effect of evidence: Bayes' Theorem and conditional probability Samples and populations, mean, standard deviation, moments, standard error. Probability distributions: binomial, normal, poisson. Limiting cases. Use of normal tables. Significance testing and confidence limits. Hypothesis testing. The chi-squared test. A brief look at probability-based arguments used by expert witnesses, recent controversies and challenged convictions. Regression and correlation

Laboratory work:
Analysis of alkaloids by HPLC
Accelerant analysis by gas chromatography
Analysis of metal cartridge cases and counterfeit coins using X-ray fluorescence spectroscopy
Determination of copper by atomic absorption spectroscopy
Quantifying substances in a mixture using UV-visible spectroscopy
Isolation & purification of caffeine from tea leaves

PS556 Firearms & Ballistics

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Spring	I	15 (7.5)	60% Exam, 40% Coursework	Shepherd Dr C

Availability

This is not available as a wild module.

Contact Hours

25 hours of lectures, 3 three hour Laboratory classes, 7 two hour Workshops.

Learning Outcomes

Understanding the internal working of a range of firearms.
Knowledge of heat transfer within firearms.
Seeing how firearms can fail and why.
Understanding how sound and flash moderators operate.
To be aware of the different methods utilised for gunshot residue analysis.
To use methods employed for serial number restoration of tampered firearms.
Be able to reconstruct bullet trajectories from crime scene evidence.
Knowledge of how to extrapolate useful information from ballistic trauma.
The consideration of all evidence at a shooting scene to reconstruct possible scenarios.
To understand the effects of Improvised Explosive Devices (IEDs) on the body and other structures.
To have a consideration of how to take a multi-disciplinary approach to ballistics.
To be aware of how up-to-date research in the field of ballistics is carried out.

Generic learning outcomes:
Building on the ballistics knowledge learned in PS324 – Introduction to Ballistics.
Increasing of students' general mathematical abilities.
The application of law to ballistics.
Develop practical skills in ballistics.
Writing of reports for different audiences.
To develop the skills required for employment in the ballistics field.

Method of Assessment

Assessment is 60% by examination and the remaining 40% by continual assessment consisting of 3 lab reports.

Preliminary Reading

Understanding Firearm Ballistics, R.A. Rinker. Mulberry Hs, USA. ISBN 0-9645598-4-6

Handbook of Firearms and Ballistics, Brian Heard, Wiley Blackwell. ISBN 0470694602

Small Arms, Derek Allsop & M Toomey, Brassey's (UK) Ltd. ISBN1857532503

Pre-requisites

PS324 - Introduction to Ballistics.

Synopsis *

Internal ballistics
Weapon failure
Suppressors
Cartridge case and bullet analyses
Gunshot residue analyses
Serial number restoration
Trajectory analyses
Wound ballistics
Shooting scene reconstruction
The effect of Improvised Explosive Devices (IEDs)
A multidisciplinary approach to ballistics
Modern Ballistics research.

PS591 Industrial Placements Experience

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	90 (45)	Pass/Fail Only	Shepherd Dr C

Availability

This is not available as a wild module.

Contact Hours

Full-time placement in an industrial environment, likely to be equivalent to a 35 hour working week over 9 to 12 months

Learning Outcomes

Subject specific learning outcomes:
On successfully completing the module students will be able to:
Gain knowledge and understanding of aspects of the core subject areas from the perspective of a commercial or industrial organisation.
Apply intellectual skills specified for the programme and developed during the earlier stages of the programme from the perspective of a commercial or industrial organisation.
Apply subject-specific skills specified for the programme and developed during the earlier stages of the programme from the perspective of a commercial or industrial organisation.

Intended generic learning outcomes:
On successfully completing the module students will be able to:
Work effectively as a member of a professional team.
Make succinct presentations (in any form) to a range of audiences about technical problems and their solutions.
Make effective use of general IT facilities including information retrieval skills.
Depending on the requirements of the placement, understand and explain the quantitative dimensions of a problem.
Manage personal learning and development, including time management and organisational skills.
Appreciate the need for, and have engaged in, continuing professional development.

Method of Assessment

By Portfolio and performance evaluation by industrial supervisor, each graded as either pass or fail.

Pre-requisites

Successful completion of Stage 1 in your respective programme at your first attempt with an average mark of 60% and a successful placement application to a company relevant to your current subject of study.

Progression

Passing of both PS591 and PS592 is required to progress on the relevant year in industry programme, otherwise, students will be continue on the relevant BSc programme without a year in industry.

Synopsis *

Students spend a year (minimum 9 months) working in an industrial or commercial setting, applying and enhancing the skills and techniques they have developed and studied in the earlier stages of their degree programme. The work they do is entirely under the direction of their industrial supervisor, but support is provided via a dedicated Placement Support Officer within the School. This support includes ensuring that the work they are being expected to do is such that they can meet the learning outcomes of the module.

PS592		Industrial Placement Assessment				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	30 (15)	100% Project	Shepherd Dr C

Availability

This is not available as a wild module.

Contact Hours

Full-time placement in an industrial environment, likely to be equivalent to a 35 hour working week over 9 to 12 months. The assessment component should take 300 study hours.

Learning Outcomes

Intended subject specific learning outcomes:
On successfully completing the module students will be able to:
Gain knowledge and understanding of aspects of the core subject areas from the perspective of a commercial or industrial organisation.
Apply intellectual skills specified for the programme and developed during the earlier stages of the programme from the perspective of a commercial or industrial organisation.
Apply subject-specific skills specified for the programme and developed during the earlier stages of the programme from the perspective of a commercial or industrial organisation.

Intended generic learning outcomes:
On successfully completing the module students will be able to:
Work effectively as a member of a professional team.
Make succinct presentations (in any form) to a range of audiences about technical problems and their solutions.
Make effective use of general IT facilities including information retrieval skills.
Depending on the requirements of the placement, understand and explain the quantitative dimensions of a problem.
Manage personal learning and development, including time management and organisational skills.
Appreciate the need for, and have engaged in, continuing professional development.
Reflect on the industrial placement experience and what they have learnt.

Method of Assessment

70% from an Industrial Placement Report (approx 30 pages) and 30% from a Presentation (20 mins)

Pre-requisites

Successful completion of Stage 1 in your respective programme at your first attempt with an average mark of 60% and a successful placement application to a company relevant to your current subject of study.

Progression

Passing of both PS591 and PS592 is required to progress on the relevant year in industry programme, otherwise, students will be continue on the relevant BSc programme without a year in industry.

Synopsis *

Students spend a year (minimum 9 months) working in an industrial or commercial setting, applying and enhancing the skills and techniques they have developed and studied in the earlier stages of their degree programme.
The report required for this module should provide evidence of the subject specific and generic learning outcomes, and of reflection by the student on them as an independent learner.

PS601		Fires and Explosions				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	80% Exam, 20% Coursework	Serpell Dr C

Availability

This is not available as a wild module.

Contact Hours

32 hours of lectures.

Learning Outcomes

The physics and chemistry of fires and explosions.
The principal areas of forensic investigation of fires and explosions.
The analysis and identification of accelerants, incendiary devices, explosives and explosive residues.
The management of fire and explosion scenes.
The observation and assessment of damage to buildings and vehicles, and injury to persons.
Identification of the causes of fires and explosions, and their classification as natural, accidental, negligent or deliberate.
Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject areas identified above.
Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems.

Method of Assessment

Examination: 80%; Coursework: 20%

Preliminary Reading

Crime Scene to Court, the Essentials of Forensic Science, 4th edition, ed. P. White. Royal Society of Chemistry,2016. ISBN: 9781782624462. Chapters 9 and 10
Criminalistics, 10th edition, R. Saferstein. Prentice Hall, 2010. ISBN: 0132545799. Chapter 11
Forensic Science, 4th edition, A.R.W. Jackson & J. M. Jackson. Pearson, 2016. ISBN: 9781292088181. Chapters 10 & 11
The Chemistry of Explosives, J. Akhavan. Royal Society of Chemistry. 3rd edition, 2011, ISBN 9781849733304; 2nd edition, 2004, ISBN: 0854046402
Kirk's Fire Investigation, J. DeHaan. Prentice Hall. 7th edition, 2011, ISBN 9780135082638

Pre-requisites

Successful completion of Stage 2 of the Forensic Science or Chemistry degree programme; or equivalent background.

Synopsis *

Physics and chemistry of fires and explosions:
Fire and arson – occurrence and importance. Combustion – definitions. Thermodynamics and enthalpy. Flammability limits, flash point, fire point, ignition temperature. Pyrolysis of wood and plastics. Fuels and accelerants. Propagation and spread of fires. Sampling and laboratory analysis of fire scene residues.
Explosions – definitions. Vapour phase and condensed phase explosions. Detonation and deflagration. High and low explosives. Primary and secondary high explosives. Molecular design of explosives. Survey of important explosives. Stoichiometry, oxygen balance, gas volumes, thermodynamics and enthalpy. Sampling and laboratory analysis of explosives residues. Preventative detection of explosives in contexts such as airports.

Fires:
Fire dynamics. Propagation and spread of fires – flames, fire types, flashover. Fire investigation. Forensic Science Service procedures at the scene. Damage observation and assessment. Fire and smoke patterns. Sources of ignition. Injuries and fatalities. Evidence recovery: sampling and laboratory analysis. Establishing the origin : the seat of the fire. Finding the cause: natural, accidental, negligent or deliberate? Indicators of arson. Evidence procedures. Case studies.

Explosions:
Control of the explosion scene and procedures for recovery of evidence. Damage observation and assessment. The work of the Forensic Explosives Laboratory. Identification of explosives: organics and inorganics. Bulk analysis. Trace analysis of explosives: recovery, extraction and analysis of samples. Physical evidence: detonators. Preventative detection. Precursor identification. Explosives evidence in court: legal definitions and procedures. Terrorism. Case studies.

PS602 Forensic Expert Witness Skills

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Autumn	H	15 (7.5)	100% Coursework	Shepherd Dr C

Availability

This is not available as a wild module.

Contact Hours

12 hours of lectures, 1 tutorial, poster session and mock court.

Learning Outcomes

Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Forensic Science.
Skills in presenting scientific material and arguments clearly and correctly, in writing and orally, to a range of audiences.
Communication skills, covering both written and oral communication.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working.

Method of Assessment

This module is assessed by coursework. Press release (20%), Poster (10%), Writing (40%) and defending (30%) an expert witness report.

Preliminary Reading

Bond, Catherine, (2007) The expert witness in court: a practical guide, 3rd Ed, Shaw
Wall, (2009) Forensic Science in Court: The role of the expert witness, Wiley Blackwell
Langford, Alan (2010) Practical skills in forensic science, 2nd ed., Pearson, Prentice Hall
Jackson and Jackson, Forensic science, Pearson Prentice Hall, 2011

Pre-requisites

Successful completion of Stage 2 of the Forensic Science degree programme; or equivalent background.

Synopsis *

Investigating how science is reported in the media. Writing a press release.
Designing and producing a poster.
Acting as an expert forensic science witness. Writing and defending an expert witness report – this currently takes place in the Canterbury Magistrates' court.

PS620		Forensic Science Project				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	30 (15)	100% Project	Shepherd Dr C

Availability

This is not available as a wild module.

Contact Hours

22 weeks or Project Work at a minimum of one full day per week for the duration.

Learning Outcomes

Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Forensic Science.
Skills in presenting scientific material and arguments clearly and correctly, in writing and orally, to a range of audiences.
Competence in the planning, design and execution of investigations, from the problem-recognition stage through to the evaluation and appraisal of results and findings; this to include the ability to select appropriate techniques and procedures.
Communication skills, covering both written and oral communication.
Interpersonal skills, relating to the ability to interact with other people and to engage in team-working.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working.

Method of Assessment

Project report 50%, Supervisor's mark 20%, Progress report 10%, Oral presentation 20%.

Preliminary Reading

Literature as indicated by the project supervisor.

Pre-requisites

None.

Synopsis *

Development of a project topic of the student's choosing.
Complete management of the project.
Writing a literature review of the selected area of investigation.
Writing a progress report.
Performing an investigation in a group setting with minimal supervision.
Giving a presentation.
Writing a project report.

PS637 DNA Analysis & Interpretation

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	60% Exam, 40% Coursework with Compulsory Numeric Elements	Green Mr R(PS)
1	Canterbury	Whole Year	H	15 (7.5)	80% Exam, 20% Coursework with Compulsory Numeric Elements	Green Mr R(PS)

Availability

This is not available as a wild module.

Contact Hours

24 hours will be spent on lectures.

One 6 hour lab class.

Learning Outcomes

Knowledge and understanding of core biological concepts, terminology, theory, units, conventions, and methods, including knowledge of cells, biochemistry and human DNA
Knowledge and understanding of concepts, principles & theories of DNA & forensic genetics, and ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems in the area of DNA.
Skills required for, and knowledge of, the analysis of forensic DNA.
Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them.
Skills in the safe handling of chemicals, taking into account their physical and chemical properties, including any hazards associated with their use and to risk assess such hazards
Ability to recognise and implement good measurement science and practice.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.

Method of Assessment

The written examination will account for 80%
DNA profiling case study will account for 10%
Lab report will account for 10%

Preliminary Reading

Publications from the learned literature including journal articles from Science & Justice and Forensic Science International
Fundamentals of forensic DNA typing (Butler 2009) – ISBN 978-0-12-374999-4
Forensic DNA typing Butler ISBN 0-12-147951-X

Pre-requisites

CH314 Introduction to Biochemistry and Drug Chemistry or equivalent.

Synopsis *

The module lectures will cover the following topics:

• Historical methods
• DNA sample collection, processing and storage
• DNA theory
• DNA databases and statistical interpretation
• Quality Assurance, management and control
• Legal aspects
• Forensic case studies
• Future trends

PS700		Physical Science Research Investigation				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
3	Canterbury	Whole Year	M	15 (7.5)	100% Project	Smith Prof M (PS)

Availability

This is not available as a wild module.

Contact Hours

10 hours of lectures, 4 hours of tutorial/workshop sessions with the convenor or with specialist supervisors, and an extended written exercise.

Learning Outcomes

Engagement and familiarity with recent and current research methods, results and publications.
<ii> An ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
<ii> An ability to execute and analyse critically the results of an experiment or investigation and draw valid conclusions. To evaluate the level of uncertainty in these results and compare them with expected outcomes, theoretical predictions or with published data; thereby to evaluate the significance of their results in this context
 Confidence in their ability to interpret complex technical information and to communicate it in a wide variety of professional situations.
 Self-direction and originality in applying and adapting problem-solving skills to unfamiliar, complex and open-ended situations.
 The independent learning ability required for continuing professional development.
 To establish advanced research skills needed at a postgraduate level or graduate level in other sectors.
 The capacity to undertake advanced scientific investigations, advanced problem solving and data analysis in a research environment.
 Ability to communicate scientific ideas through presentations and written reports.
 To gain knowledge of how postgraduate research is structured and funded.
 Time management and forward planning skills.

Method of Assessment

100% coursework. The coursework assesses students' familiarity with and ability to implement current research methods.

Preliminary Reading

 http://www.epsrc.ac.uk/
 http://www.scitech.ac.uk
On writing proposals:
 https://www.epsrc.ac.uk/funding/howtoapply/preparing
Peer Review:
 http://www.rin.ac.uk/our-work/communicating-and-disseminating-research/peer-review-guide-researchers
GUIDES FOR WRITING A FUNDING PROPOSAL
 http://www.learnerassociates.net/proposal/
 http://www.learnerassociates.net/proposal/

Pre-requisites

None.

Synopsis *

Aims:
<ii> Students will develop a number of skills related to the Investigation and planning of research. Students will learn how to search and retrieve information from a variety of locations (databases, websites, journals, proceedings etc). They will learn how to compile professionally-produced documents such as the report of their own investigation in a direction of their choice. In addition, students will subsequently provide an outline proposal for funding for future research activity.

Through two Colloquium Reports, students will learn to write high-impact articles with a critical analysis of research presented by others. They will exercise presentation skills and present critical reviews and referee's reports of the research of others.

SYLLABUS:
The Research Project (60%)
Identification of a research area and the issues to tackle
Investigation of an unresolved issue comparing experiments and models, comparing approaches, assumptions and statistical methods.
Production of a dissertation
Proposal for future novel work as a short Case for Support for a PhD or research outside university environment
Project Management: Scheduling research programmes, Gantt, PERT charts.
Project Management: Costing of research, full economic cost, direct and indirect costs.
Poster presentation of the research

Research Review and Evaluation (40%)
Evaluation of Research: Colloquium attendance/viewing.
Science Communication: Preparation of two colloquium reports as a science magazine article with impact
Referee report on the colloquiums: strengths, weaknesses of both the speaker and the research quality.

Details of the work to be done will be announced by the convenor during the first two weeks of the academic year.

PS701 Topics in Functional Materials

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	M	15 (7.5)	80% Exam, 20% Coursework	

Availability
This is not available as a wild module.

Contact Hours
28 hours of lectures, 3 hours of examples classes.

Learning Outcomes
A systematic understanding and a critical awareness of current topics of interest in materials research.
A comprehensive understanding of techniques applicable for synthesis and purification of materials.
A comprehensive understanding of techniques applicable for chemical and physical characterisation methods of materials.
A critical awareness of the applications of materials in industry.
A systematic understanding of knowledge relating to materials.
An ability to apply the knowledge to solve problems in materials.
An understanding of the fundamental phenomena of the electronic structure of materials.
An appreciation of the key driving forces in nanoscience and knowledge of selected important nanomaterials and phenomena at the forefront of the discipline.
Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems, extending to situations where evaluations have to be made on the basis of limited information.

Method of Assessment
Examination: 80%; Coursework: 20%.

Preliminary Reading
- Wright, Molecular Crystals, Cambridge University Press, 1995, [QD921].
- Solid state chemistry and its applications - Anthony West, Anthony R. West 2014
- Smart and Moore, Introduction to Solid State Chemistry, Chapman & Hall, 1992, [QD454].
- Agullo-Lopez, Catlow and Townsend, Point Defects in Materials, Academic, 1988, [QC 176.8.D3].
- A. P. Sutton, “The electronic structure of materials”, Oxford University Press ISBN: 0198517548
- Interrante and Hamden-Smith, “Chemistry of Advanced Materials” Wiley, 1998 [TA403]
- Philibert “Atom Movements”, Editions de Physique, 1991 [QC176]
- Dieter Vollath “Nanomaterials: An Introduction to Synthesis, Properties and Applications”
- Supplemented by up-to-date research literature from “Web of Science” and lecturers’ own research publications in peer-reviewed journals.

Pre-requisites
None.

Synopsis *
Chemists and physicists are now playing an important role in the growing field of materials research. More recently there has been a growing interest, driven by technological needs, in materials with specific functions and this requires a combination of physics and chemistry. For example, new materials are needed for the energy industry (batteries and fuel cells), for the optics and electronics industry (semiconductors, lasers and wave-guides), and for the environment (sensors, actuators and ‘smart’ materials). The aim of this module is to introduce students to this area of modern materials and techniques.

Examples of the topics that might typically be covered are:
1. Crystal growth and defects.
2. Liquid crystals.
3. Magnetism and Magnetic Materials.
4. X-ray absorption spectroscopy (XAS).
5. Nanomaterials.
6. Multiferroics.

PS713	Substances of Abuse					
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	M	15 (7.5)	70% Exam, 30% Coursework	Biagini Dr S

Availability

This is not available as a wild module.

Contact Hours

Approximately 16 hours will be spent on timetabled lectures, 8h spent on timetabled student presentations.

Learning Outcomes

To acquire a knowledge and understanding of the theoretical chemistry and the principles of analysis and identification of several chemicals that are related to substances of abuse.
Display an ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject areas identified in the syllabus.
Display an ability to apply such knowledge to qualitative and quantitative problem solving in the relevant subject area.
Display an ability to communicate complex scientific topic in the form of an audio-visual presentation.

Method of Assessment

Examination: 70%, Coursework: 30%.

Preliminary Reading

Clarke's Analytical Forensic Toxicology, Pharmaceutical Press;1 edition (30 Jun 2008)
ISBN-10: 0853697051; ISBN-13: 978-0853697053.

Michael D. Cole; The Analysis of Controlled Substances: A Systematic Approach. Cole2003.
ISBN 0-471-49253-1.

Coleman, Michael D., Human Drug Metabolism: an introduction, 2010. ISBN: 13-9780470742167

Perrine, Daniel M., The Chemistry of Mind-Altering Drugs: History, Pharmacology and Cultural Context, 1996. ISBN: 13-9780841232532

Stevens, A., Drugs, Crime and Public Health: the political economy of drug policy, 2011. ISBN: 13-9780203844168

Pre-requisites

CH314

Synopsis *

Elements of synthetic organic chemistry and medicinal chemistry which are relevant to substances of abuse.
The theoretical chemistry and principles of analysis and identification of several substances that are substances of abuse. The following are indicative:
o amphetamines and related compounds
o LSD and related compounds
o Cannabis and Cannabis products
o opiate compounds
o cocaine and related compounds
o certain controlled pharmaceutical drugs.

PS720	Advanced Project Laboratory					
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
3	Canterbury	Whole Year	M	30 (15)	55% Project, 45% Coursework	Barker Dr R

Availability

This is not available as a wild module.

Contact Hours

8 x 2 hour lectures, Training session 1 x 4 hr
Workshops 4 x 2 hr, 6 (6 hour) laboratory days.

This module is expected to occupy 300 total study hours including the contact hours above.

Learning Outcomes

Knowledge and understanding of core scientific physical, biological, and chemical concepts, terminology, theory, units, conventions and laboratory methods in relation to forensic science.
Knowledge and understanding of advanced theory, concepts, and practice in the forensic field.
Knowledge and understanding of areas of chemistry (including analytical chemistry), numeracy (including data analysis and statistics), forensic investigation and interpretation (including the extraction, analysis, interpretation of physical evidence).
Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to the subject and to apply such knowledge and understanding to the solution of qualitative and quantitative problems.
Ability to recognise and solve forensic related problems at an advanced level.
Ability to recognise and implement good measurement science and practice and commonly used forensic laboratory techniques.
Ability to select the most appropriate techniques for a given analysis and to use a wide range of advanced apparatus.
Skills in the safe handling of chemical materials, taking into account their physical and chemical properties, including any specific hazards associated with their use and to risk assess such hazards.
Skills required for the conduct of standard laboratory procedures involved in analytical work and in the operation of standard forensic instrumentation such as that used for analytical investigations and separation.
Ability to interpret data derived from laboratory observations and measurements in terms of their significance and the theory underlying them.
Communication skills, covering both written and oral communication.
Numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, correct use of units and modes of data presentation.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
Information-technology skills such as word-processing and spreadsheet use, data-logging and storage, Internet communication, etc.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working.
Skills relevant to a career in forensic science practice and forensic research.

Method of Assessment

100 % Coursework: The first section of the module will be assessed by a report (1,000 word equivalent) written on each experiment, with detailed analysis of the results obtained in the laboratory. 45% of the marks.
The project component of the module (55% of marks) will include presentation and dissertation (5,000 words). The presentation will give an oral overview of the planning, experimental work and conclusions in the project. The dissertation will include a detailed account of the measurements made in the laboratory to establish the detection limit of the chosen experimental method, together with a critical literature survey of the application of the method in Forensic Science, including recent casework.

Preliminary Reading

Literature as indicated by the project supervisor.

Pre-requisites

None.

Restrictions

School of Physical Sciences
Procedures for Projects Involving Human Participation

It is a University requirement that any final year project undergraduate, postgraduate or staff research project involving human participants should be subject to a procedure to determine whether ethics approval is needed. The procedure employed by SPS and the Faculty of Science are described here:
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html

Undergraduate projects PH600, PH603, PS620, CH620, PS720, PS740 and PH700
Each project proposal collected from academics will include an ethics approval checklist designed to determine if ethical approval is required from the faculty i.e. does the project involve human participants. It is the responsibility of convenors to ask supervisors to fill in these checklists with students. If the answer to any of the questions on the checklist is yes please see below;

The following text will be introduced into the information pack or the handbooks of the module:

“Before you commence any work, it is important that the ethics of that work be considered; for example, taking fingerprints or collecting images of faces of your colleagues etc. Your supervisor will discuss any ethics issues with you and you should keep a copy of the documentation”

For projects involving human participants other than those conducting the project itself, students and their supervisors are required to read, note and act upon the guidelines available at
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html to obtain approval from the Sciences Research Ethics (Human Participation) Advisory Group.

Further information on Ethics can be obtained from Dr Donna Arnold, SPS representative on the Sciences Research Ethics Advisory Group.

Synopsis *

The module is designed to give students experience of a range of advanced laboratory methods with wide application in the Chemical Industry and modern Forensic Science. These methods will underpin Stage 4 research projects (PS740 and CH740) as well as advanced concepts in the Stage 4 program.

The module will be in two sections. In the first section, taught in the Autumn Term, students will receive training in a range of advanced chemical and physical laboratory methods. This section of the module will be assessed by a report written on each experiment. In the second section, beginning towards the end of the Autumn term and continuing throughout the Spring Term, students will select a topic for an extended self-directed literature review. This will evaluate the available literature on a subject and allow the student to develop critical thinking. This section of the module will be assessed by oral presentation and a written dissertation.
Experiments will include such as (NB this is an illustrative list):

Gas chromatography – mass spectrometry
Important example of modern hyphenated analysis techniques. Used in analysis of accelerant and explosive traces at scenes of fires and explosions, also in analysis of drugs of abuse.

Atomic absorption spectroscopy
Used in the analysis of trace metal content. Experiment to compare flame and graphite furnace methods.

NMR spectroscopy
Universally used in analysis of organic substances. Experiment to manipulate FID curves, to explore peak resolution and detect contaminants in samples such as counterfeit medicines.

X-ray fluorescence
Used in analysis of metal artefacts, including bullet casings and forged coins.

X-ray diffraction
Used in analysis of materials with crystalline lattices, including metals and inorganic explosives residues.

Electron microscopy
SEM, TEM and Electron Probe Microanalysis (EPMA) in the analysis of gunshot and explosives residues.

Raman spectroscopy
Used in forensic analysis of ink pigments, street drugs and counterfeit pharmaceuticals.

HPLC
Widely used method of separating and identifying substances in forensic science.

UV-visible/fluorescence spectroscopy
Used in comparison of pigments and paper in questioned documents; also chemical tests for explosives and drugs of abuse.

Image processing
Facial recognition software, signature comparison, and the reconstruction of CCTV images.

PS740 Forensic Science Research Project MSCI

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
2	Canterbury	Whole Year	M	60 (30)	100% Project	Arnold Dr D

Availability

This is not available as a wild module.

Contact Hours

Minimum of 2 days per week for 22 weeks.
This module is expected to occupy 600 total study hours including the contact hours above.

Learning Outcomes

• To build on the research independence gained in year 3 as part of PS720 (Advanced Forensic Science Laboratory).
• To establish advanced research skills at M level.
• The capacity to undertake advanced scientific investigations, advanced problem solving and data analysis in a research environment.
• Ability to communicate scientific ideas through presentations and written reports.
• In conjunction with PS700 (Physical Science Research Planning) to gain knowledge of how research is structured and funded.
• Time management and forward planning skills

Method of Assessment

100% coursework, this can be broken down into the following;
 Project report (50%) - this report will include a detailed account, analysis and interpretation of the experiments conducted in the laboratory including a detailed literature review.
 Oral presentation (20%) - this presentation will be aimed at communicating the aims and motivations of the research conducted as well as presenting background information, key results and conclusions.
 Supervisor mark (20%) - this will allow the supervisor to assess the students' progress and competency within the laboratory.
 Progress report (10%) - the progress report will allow for the assessment of the project about half way through and allow for the student to assess their own progress in relation to their objectives as well as assess what is required moving forward.

Preliminary Reading

Appropriate learned journals and texts as set by project supervisor and sourced by student

Pre-requisites

Completion of Stage 3 Forensic Science to a prescribed threshold (50% average mark with no credits to be awarded by compensation).

Restrictions

School of Physical Sciences
Procedures for Projects Involving Human Participation

It is a University requirement that any final year project undergraduate, postgraduate or staff research project involving human participants should be subject to a procedure to determine whether ethics approval is needed. The procedure employed by SPS and the Faculty of Science are described here:
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html

Undergraduate projects PH600, PH603, PS620, CH620, PS720, PS740 and PH700
Each project proposal collected from academics will include an ethics approval checklist designed to determine if ethical approval is required from the faculty i.e. does the project involve human participants. It is the responsibility of convenors to ask supervisors to fill in these checklists with students. If the answer to any of the questions on the checklist is yes please see below;

The following text will be introduced into the information pack or the handbooks of the module:

“Before you commence any work, it is important that the ethics of that work be considered; for example, taking fingerprints or collecting images of faces of your colleagues etc. Your supervisor will discuss any ethics issues with you and you should keep a copy of the documentation”

For projects involving human participants other than those conducting the project itself, students and their supervisors are required to read, note and act upon the guidelines available at
http://www.kent.ac.uk/stms/faculty/adminprocedures/research-ethics/index.html to obtain approval from the Sciences Research Ethics (Human Participation) Advisory Group.

Further information on Ethics can be obtained from Dr Donna Arnold, SPS representative on the Sciences Research Ethics Advisory Group.

Synopsis *

Students will undertake a project from an available project listing and will work under the guidance of a supervisor. The student will be encouraged to develop some level of research independence within the project remit appropriate of an M-level masters' student. The project will be assessed on a number of criteria which will include the project work (the amount, quality etc appropriate for the level), effort put in by the student, the preparation of a written report and an oral presentation session. The student’s progress will be assessed at the end of the first term through some form of progress report. This will also involve some degree of forward planning such that the students assess their own project requirements for the following term allowing the student to learn time management and forward planning skills.

Aims:
• To conduct individual masters level research.
• To develop research independence such that the student can take responsibility for the research direction of the project within the confines of the project remit.
• To further deepen the student’s knowledge within a specific research area.
• To prepare students for independent research careers in industry or at PhD level.
• To further enhance student’s abilities for scientific communication through oral presentations and report writing.
• Time management and forward planning skills