26 School of Physical Sciences

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	
1	Canterbury	Whole Year	I	15 (7.5)	70% Exam, 30% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 70
Total Private Study Hours: 180
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of core and foundation scientific physical and chemical concepts, terminology, theory, units and conventions to chemistry and forensic science.
Demonstrate knowledge and understanding of areas of organic chemistry (organic functional groups, organic materials and compounds, synthetic pathways) as applied to chemistry and forensic science.
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.
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.
Recognise and implement good measurement science and practice and commonly used chemistry and forensic laboratory techniques.
Demonstrate confident 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.
Demonstrate 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.
Interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate confident problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Demonstrate information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.
Demonstrate confident interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment.
Demonstrate assured 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.
Demonstrate study skills needed for continuing professional development and professional employment.

Method of Assessment

Assignment 1 (2.5 hours) – 3%
Assignment 2 (2.5 hours) – 3%
Lab Write-ups (2.5 hours each) – 24%
Examination (2 hours) – 70%

The lab write-ups are compulsory sub-elements and must be passed to complete the module.

Preliminary Reading

Clayden, J., Greeves, N., and Warren, S.G. (2012). Organic Chemistry, Second Edition. Oxford: Oxford University Press.
Smith, M. (2013). March's Advanced Organic Chemistry: Reactions, Mechanisms, and Structure, Seventh Edition. London: Wiley
Warren, S.G. and Wyatt, P. (2008). Organic Synthesis: The Disconnection Approach, Second Edition. London: Wiley
Willis, C.L. and Wills, M. (1995). Organic Synthesis. Oxford: Oxford University Press.

Pre-requisites

None

Synopsis *

You will study organic reactions and compounds encountered in organic chemistry in depth. In particular, you will look at the organic chemical reaction mechanisms (including aspects of physical organic chemistry) and the reactions of a variety of organic compounds. You will also look at carbon-carbon forming reactions and strategies for synthesising target molecules.

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	
1	Canterbury	Whole Year	I	15 (7.5)	70% Exam, 30% Coursework	
1	Canterbury	Whole Year	I	15 (7.5)	65% Exam, 35% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 44
Private study hours: 104
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have:
Knowledge and understanding of core and foundation scientific physical and chemical concepts, terminology, theory, units and conventions to chemistry and forensic science. FS/FC A1. Chem A1.
Knowledge and understanding of areas of analytical, physical, organic and inorganic chemistry as applied to chemistry and forensic science. FS/FC A3. Chem A3.
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. FS/FC B1. Chem B5.
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. FS/FC B2. Chem B6.
Ability to recognise and implement good measurement science and practice and commonly used chemistry and forensic laboratory techniques. FS/FC B4. Chem B4.
Ability to interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them. FS/FC C6. Chem C11.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have:
Interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment. FS/FC C6. Chem C19.
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. FS/FC C6. Chem C20.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information. FS/FC D2. Chem D15.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches. FS/FC D4. Chem D17.
Study skills needed for continuing professional development and professional employment. FS/FC D9. Chem D21.

Method of Assessment

Assignment 1 – 17.5%
Assignment 2 – 17.5%
Examination (2 hours) – 65%

Preliminary Reading

Core (Compulsory) Text for all students taking CH506
Spectroscopic methods in organic chemistry - Dudley H. Williams, Ian Fleming, 6th edition 2008

Pre-requisites

Prerequisites:
CHEM3080 Molecules, Matter and Energy
CHEM3090 Fundamental Chemistry for Physical Scientists
CHEM3140 Introduction to Biochemistry and Drug Chemistry
PSCI3810 Chemical Skills for Forensic Scientists
or
CHEM3820 Chemical Skills

Synopsis *

You will develop an understanding of the theory and application of common techniques for the chemical identification of molecular species. Techniques studied will include nuclear magnetic resonance (NMR), mass spectrometry (MS), infrared and Raman spectroscopy and UV-vs spectrophotometry / fluorimetry.

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	

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 45
Total Private Study Hours: 105
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate detailed knowledge and understanding of the fundamental concepts relating to polymer chemistry.
Demonstrate thorough knowledge and understanding of the operating instruments and interpreting spectra from spectroscopic data.
Demonstrate detailed knowledge and understanding of the structure-property relationships liquid-crystal (LC) materials.
Demonstrate in-depth knowledge and understanding of the synthetic approaches to polymers, LCs, and light emitting organics.
Demonstrate through knowledge and understanding of the concepts relating to spectroscopy and organic light emitting devices.
Confidently interpret spectroscopic data.
Demonstrate an assured ability to link chemical structure to experimental observables.
Display the skills to perform practical experiments to gain spectroscopic information.
Display the skills to accurately operate standard chemical instrumentation, record data, evaluate observations and errors.
Display the skills to accurately operate standard chemical instrumentation, record data, evaluate observations and errors.
Demonstrate a thorough understanding of how polymers are synthesised and analysed.
Demonstrate a detailed understanding of small molecule synthesis approaches.
Display knowledge of LC behaviour and how it relates to observable properties.
Demonstrate a thorough understanding of OLED device compositions.
Make use of appropriate subject-specific texts, or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate the 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.
Demonstrate assured 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.
Work independently, use initiative, organise oneself to meet deadlines, and interact constructively with other people.

Method of Assessment

Assignment 1 (14%)
Assignment 2 (8%)
Laboratory Practical Reports – 18%
Examination (2 hours) – 60%

The lab practical reports are compulsory sub-elements and must be passed to complete the module.

Preliminary Reading

Collins, P.J. and Hird, M. (1997). Introduction to Liquid Crystals: Chemistry and Physics. Boca Raton, FL: CRC Press
Cowie, J.M.G., and Arrghi, V. (2007). Polymers: Chemistry and Physics of Modern Materials. Third Edition. Boca Raton, FL: CRC Press
Jean, Y., Volatron, F. and Burdett, J. (1993). An Introduction to Molecular Orbitals. Oxford: Oxford University Press.
Solomons, G., Fryhle, C.B., and Snyder, S.A. (2012). Organic Chemistry, Eleventh Edition. London: Wiley
Sun, S-S. and Dalton, L.R. (2016). Introduction to Organic Electronic and Optoelectronic Materials and Devices, Second Edition. Boca Raton, FL: CRC Press

Pre-requisites

None.

Synopsis *

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.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 60
Private study hours: 90
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Understand and apply basic concepts in chemical thermodynamics.
Predict the feasibility of a chemical reaction.
Recognise the links between the macroscopic thermodynamic and microscopic statistical viewpoints.
Understand electrochemical reactions and processing.
Understand molecular reaction dynamics.
Perform calculations using thermodynamic data.
Perform practical experiments to gain thermodynamic information.
Operate standard chemical instrumentation, record data, evaluate observations and errors.
Present and interpret information graphically.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assignment 1 (3 hours) – 9%
Assignment 2 (3 hours) – 6%
Laboratory Report (3 hours) – 25%
Examination (2 hours) – 60%

Preliminary Reading

P.W Atkins, Physical Chemistry
R. Chang, Physical Chemistry for the Chemical and Biological Sciences

Pre-requisites

Prerequisites:
CHEM3080 Molecules Matter & Energy
CHEM3820 Chemical Skills
CHEM3200 Chemical Reactions

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	

Availability
This is not available as a wild module.

Contact Hours
Total contact hours: 56
Private study hours: 94
Total study hours: 150

Learning Outcomes
The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have the 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:
Link quantum mechanical theories to experimental observables.
Interpret spectroscopic data.
Perform practical experiments to gain spectroscopic information.
Operate standard chemical instrumentation, record data and evaluate observations and errors.

Subject-specific skills:
Demonstrate knowledge of basic spectroscopy; microwave, infrared, UV-VIS, Raman.
Perform calculations on molecular parameters from spectroscopic data.
Understand quantum mechanical concepts underlying bonding and energy transitions experimentally observed in spectroscopy.
Understand symmetry of molecules to determine spectroscopic data.
Make use of appropriate texts, or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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
Assessment 1 (2 hours) – 5%
Assessment 2 (2 hours) – 5%
Assessment 3 (2 hours) – 5%
Practicals (equivalent to 16 pages) – 25%
Examination (2 hours) – 60%

Preliminary Reading
P.W Atkins, Physical Chemistry (2014)
C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy (1994)
Y. Jean, F. Volatron and J. Burdett, An Introduction to Molecular Orbitals (1993)

Pre-requisites
Prerequisites:
CHEM3080 Molecules Matter & Energy
CHEM3200 Chemical Reactions
CHEM3820 Chemical Skills

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). 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	

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 82
Total Private Study Hours: 68
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate an ability to describe, with confidence, the features of the most common crystalline structures.
Demonstrate the ability to identify different bonding contributions in the solid state.
Demonstrate the ability to relate the crystalline structure with the bonding to predict materials properties.
Demonstrate assured ability to describe different defect structures in the solid state and how they affect the materials properties.
Demonstrate an assured ability to interpret and draw phase diagrams.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate the 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.
Demonstrate thorough 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.
Demonstrate the ability to work independently, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.

Method of Assessment

Assignment 1 (3 hours) – 7.5%
Assignment 2 (3 hours) – 7.5%
Practical Lab Reports (3 hours each) – 25%
Examination (2 hours) – 60%
The assignments are compulsory sub-elements and must be passed to complete the module.

Preliminary Reading

Smart, L. E. and Moore, E. A. (2020). Solid State Chemistry: An Introduction, Fifth Edition Boca Raton, FL: CRC Press
West, A. (2014). Solid State Chemistry and its Applications, Second Edition. London: Wiley

Pre-requisites

None

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 and nanomedicine.

CH534 Inorganic and Environmental Chemistry

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 41
Private study hours: 109
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Understand the characteristic properties of the d and f-blocks elements and their compounds.
An understanding of the composition of soil and its analysis.
Appreciate developments in soil analysis and environmental chemistry in terms of heavy metal toxicity, diffusion, detection and remediation.

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. In particular, the ability to link chemical structure to physical properties.
Ability to recognise and analyse problems and plan strategies for their solution by the evaluation, interpretation and presentation of scientific information and data.
The ability to use data-processing skills to search for, assess and interpret chemical information and data, particularly in performing comprehensive literature searches.

Subject-specific skills:
A knowledge and understanding of soil structure in relation to silicate composition, and how this affects ion diffusion in soils.
A knowledge and understanding of the impact of heavy metal toxicity environmental mobility and bio-availability.
An understanding of preparation, purification and analysis of a range of inorganic compounds using techniques such as ion-exchange chromatography, infrared and uv-vis spectroscopy.
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, and the ability to implement the execution of experiments.
Skills required for carrying out documented standard laboratory procedures involved in synthetic and analytical work in relation to organic and inorganic systems. Skills in observational and instrumental monitoring of physiochemical events and changes. The systematic and reliable documentation of the above. Operation of standard analytical instruments employed in the chemical sciences.
The ability to collate, interpret and explain the significance and underlying theory of experimental data, including an assessment of limits of accuracy.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
Communication skills, covering both written and oral communication.
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.
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.
An ability to make use of appropriate texts, or other learning resources as part of managing their own learning.

Method of Assessment

Assignment 1 (~2 hours) – 7.5%
Assignment 2 (~2 hours) – 7.5%
Practical Laboratory Reports (~3 hours) – 25%
Examination (2 hours) – 60%

Preliminary Reading

Cotton, Wilkinson and Gaus, Basic Inorganic Chemistry, (3rd edition, 1995, Wiley).
Greenwood and Earnshaw, Chemistry of the Elements, (2nd revised edition, 1997, Butterworth-Heinemann Ltd)
Winter, d-Block Chemistry, (1994, Royal Society of Chemistry)
Jones, d- and f-Block Chemistry, (2001, Royal Society of Chemistry)
Bell, Forensic Chemistry, (2nd edition, 2012, Prentice Hall)
Tan, Principles of Soil Chemistry, (2010, CRC Press)
Sparks, Environmental Soil Chemistry, (2003, Academic Press)

Pre-requisites

Prerequisite:
CHEM308 Molecules, Matter and Energy
CH382

Synopsis *

Here, you will explore the chemistry of the d- and f-block elements, including their electronic and colour properties as well as their magnetic behaviour, both in lectures and workshops and also practically through a lab component. Environmental chemistry is of growing importance and this module will also equip you to understand environmental concerns such as toxicity, bioavailability and environmental mobility. (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	
1	Canterbury	Whole Year	H	15 (7.5)	80% Exam, 20% Coursework	
1	Canterbury	Whole Year	H	15 (7.5)	75% Exam, 25% Coursework	
1	Canterbury	Whole Year	H	15 (7.5)	100% Exam	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of core and foundation scientific physical, biological and chemical concepts, terminology, theory, units, conventions, and laboratory methods in relation to the chemical and forensic sciences.
Demonstrate knowledge and understanding of areas of chemistry including analytical chemistry, including as applied to forensic analysis.
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.
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.
Collate, interpret and explain the significance and underlying theory of experimental data, including an assessment of limits of accuracy.
Interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them. (Forensic Science/Chemistry).

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Demonstrate knowledge and understanding of numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, and correct use of units and modes of data presentation.
Demonstrate 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.
Demonstrate study skills needed for continuing professional development and professional employment.

Method of Assessment

Assignment 1 (4 hours) – 12.5 %
Assignment 2 (4 hours) – 12.5 %
Examination (3 hours) – 75%

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

Prerequisite:
CHEM5060 Chemical Identification Techniques

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), mass spectrometry and 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	

Availability
This is not available as a wild module.

Contact Hours
Total contact hours: 25
Private study hours: 275
Total study hours: 300

Learning Outcomes
The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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
Project Report (about 20-25 sides of A4 excluding figures and tables etc, 50%)
Progress Report (2 pages, 10%)
Presentation (15 minutes, 20%)
Supervisor Mark (20%)

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.

CH622 Topics in Inorganic Synthetic Chemistry

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

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 42
Total Private Study Hours: 108
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate comprehensive understanding and knowledge of core and foundation scientific concepts, terminology, theory, units, conventions, and laboratory practice and methods in relation to inorganic synthetic chemistry.
Demonstrate wide-ranging knowledge of areas of inorganic synthetic chemistry including synthetic pathways of inorganic materials, such as sol-gel, "shake and bake" and high-pressure synthesis.
Demonstrate full appreciation of developments at the forefront of some areas of inorganic materials chemistry such as nanoparticles and catalysts.
Demonstrate extensive knowledge and understanding of inorganic synthetic chemistry methods and to apply such knowledge and understanding to the solution of qualitative and quantitative problems in inorganic synthetic chemistry.
Recognise and analyse problems in inorganic synthetic chemistry and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data.
Display professional 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.
Display confident skills required for carrying out documented standard laboratory procedures involved in synthetic work in relation to inorganic systems. Skills in observational and instrumental monitoring of physiochemical events and changes. The systematic and reliable documentation of the above. Operation of standard analytical instruments employed in the chemical sciences.
Collate, interpret, and explain the significance and underlying theory of experimental data, including an assessment of limits of accuracy.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate assured communication skills.
Display the ability to identify and undertake further training of a professional nature.
Demonstrate comprehensive problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Demonstrate confident numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, correct use of units and modes of data presentation.
Demonstrate assured interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment.
Demonstrate 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.

Method of Assessment

Assignment 1 (7 hours) – 12.5%
Assignment 2 (7 hours) – 12.5%
Lab Reports (7 hours each) – 15%
Examination (3 hours) – 60%
The assignments and the lab reports are compulsory sub-elements and must be passed to complete the module.

Preliminary Reading

Smart, L. and Moore, E. (2012). Solid State Chemistry: An Introduction, Fourth Edition. Boca Raton, FL: CRC Press.
Schubert, U. and Husing, N. (2019) Synthesis of Inorganic Materials, Fourth Edition. Weinheim: Wiley-VCH.
West, A.R. (1999). Basic Solid State Chemistry, Second Edition. Chichester: Wiley.

Pre-requisites

None

Synopsis *

'Nanoscience will sculpt the scientific landscape of the 21st century.' Here, you will be exposed to the synthesis of nanomaterials spanning nanoparticles, nanorods and porous architectures. You will learn how to control their shape, size, functionalisation, and stabilisation for a wide range of applications. The synthesis of functional inorganic solid is also introduced, including conventional solid-state synthesis, the use of intercalation and high-pressure synthesis to prepare novel materials and how solid-state materials can be synthesised at lower temperatures via solution-based methods. You will also synthesise several functional inorganic solids and nanomaterials in our chemistry laboratory.

CH623 Main Group and Organometallic Chemistry

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	15 (7.5)	75% Exam, 25% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 45
Total Private Study Hours: 105
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate complete understanding and knowledge of core and foundation scientific chemical, physical and biological concepts, terminology, theory, units, conventions, and laboratory practice and methods in relation to the chemical sciences.
Demonstrate wide-ranging knowledge of areas of chemistry including properties of chemical elements, states of matter, organic functional groups, physiochemical principles, organic and inorganic materials, synthetic pathways, analytical chemistry, drug chemistry, biochemistry, fires, and explosions.
Demonstrate Abroad appreciation of developments at the forefront of some areas of chemical sciences.
Demonstrate comprehensive 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.
Recognise and analyse problems and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data.
Display skills in the safe handling of chemical materials, considering their physical and chemical properties, including any specific hazards associated with their use and to risk assess such hazards. Concepts in NMR (paramagnetic NMR, quadrupolar NMR, Variable temperature NMR).
Display skills required for carrying out documented standard laboratory procedures involved in synthetic and analytical work in relation to organic and inorganic systems; skills in observational and instrumental monitoring of physiochemical events and changes; the systematic and reliable documentation of the above; operation of standard analytical instruments employed in the chemical sciences; synthetic techniques and reaction conditions for common organometallic syntheses; synthetic techniques and reaction conditions for main group compounds; and identifying Lewis acidic and Lewis basic sites within molecules.
Demonstrate the ability to collate, interpret and explain the significance and underlying theory of experimental data, including an assessment of limits of accuracy. Ability to make use of appropriate texts, or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate assured communication skills.
Display the ability to identify and undertake further training of a professional nature.
Demonstrate comprehensive problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Demonstrate confident numeracy and computational skills, including such aspects as error analysis, order-of-magnitude estimations, correct use of units and modes of data presentation.
Demonstrate assured interpersonal skills, relating to the ability to interact with other people and to engage in team working within a professional environment.
Demonstrate 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.

Method of Assessment

Moodle Test 1 (1 hour) – 2.5%
Moodle Test 2 (1 hour) – 2.5%
Workshop 1 (1 hour) – 2.5%
Workshop 2 (1 hour) – 2.5%
Laboratory Practical Write-ups – 15%
Exam (3 hours) – 75%
The laboratory practical write-ups are compulsory sub-elements and must be passed to complete the module.

Preliminary Reading

Bochmann, M. (2015). Organometallics and Catalysis: An Introduction. Oxford: Oxford University Press.
Iggo, J.A. and Luzyanin, K. (2020). NMR Spectroscopy in Inorganic Chemistry, Second Edition. Oxford: Oxford University Press
Ghosh, A. and Berg, S. (2014). Arrow-pushing in Inorganic Chemistry: A Logical Approach to the Chemistry of the Main Group Elements. Hoboken, NJ: Wiley
Norman, N.C. (1997). Periodicity and the s- and p-Block Elements. Oxford: Oxford University Press.
Weller, M., Overton, T., Rourke,J., and Armstrong, F.A. (2014). Inorganic Chemistry, Sixth Edition. Oxford: Oxford University Press.

Pre-requisites

None

Synopsis *

The nature of chemical bonding changes as you move across and down the periodic table. In this module, you will study how and why this bonding changes, and how we can use our understanding of this to understand the structure and reactivity of many classes of compounds. This is coupled to advanced analytical techniques for probing these often complex and flexible structures. The concepts developed then feed into the reactivities underpinning modern Organometallic catalysis, moving from pure fundamentals to application and showing how they let us understand the cutting edge of modern research and industrial syntheses.

CH624 Transformations and Chirality in Organic Chemistry

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 33
Private study hours: 117
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
Core and foundation scientific chemical, concepts, terminology, theory, and methods in relation to the chemical sciences.
Areas of chemistry including properties of chemical elements, organic functional groups, physiochemical principles, organic reactivity, organic materials, and synthetic pathways.
Appreciate developments at the forefront of some areas of chemical sciences relating to organic chemistry.

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.

Subject-specific skills:
The ability to collate, interpret and explain the significance and underlying theory of experimental data pertaining to: classes of chirality and chirality resolution; chiral synthesis: carbonyls, auxiliaries, protecting groups, oxidation, enolate and aldol reactions; chemistry of double bonds: pericyclic reactions, frontier orbital theory, Woodward Hoffman rules; classical heterocyclic syntheses; targeted synthesis of topical organic molecules

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
Written skills in communication of chemical information.
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.
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.

Method of Assessment

Assignment 1 (4 pages) – 20%
Assignment 2 (4 pages) – 20%
Examination (3 hours) – 60%

Preliminary Reading

Primary: G. Solomons, Organic Chemistry 11th Ed.
Clayden, Greeves, Organic Chemistry 2nd Ed.
Secondary: Principles of Asymmetric Synthesis by Gawley, and Aube

Selections of primary journal literature will be provided.

Pre-requisites

Prerequisites:
CHEM3090 Fundamental Organic Chemistry for Physical Scientists
CHEM3820 Chemical Skills / PSCI3810 Chemical Skills for Forensic Scientists
CHEM3140 Introduction to Biochemistry and Drug Chemistry

Co-requisite:
CHEM5060 Chemical Identification Techniques

Synopsis *

A key component to chemical education is the exposure to more advanced aspects of chirality, and chemical transformations towards the synthesis of organic targets. Concepts relating to the synthesis of natural and unnatural target molecules through organic chemical transformations are essential to the students' chemical repertoire. In-depth exposure to chirality, exposure to asymmetric chemical transformations, carbon-carbon bond-forming reactions, and their application in targeted small molecule synthesis will be covered.

CH740 MChem Research Project

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	M	75 (37.5)	100% Project	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 196
Private study hours: 554
Total study hours: 750

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Procedures:
Understand the procedures and skills required to undertake a research project in chemistry.

Information:
A critical awareness of current research at the forefront of chemistry and discipline boundaries, together with the capacity to evaluate its relevance to scholarship, industrial and commercial practice where appropriate.
The ability to acquire and assimilate information effectively in any appropriate medium, including the increasing range of networked information resources where relevant.
Critical understanding of the reliability of data from various sources (spanning peer reviewed articles in prominent journals, online databases (e.g. RSC ChemSpider), Wikipedia, newspaper articles, web based discussion forums).
Demonstrate conceptual thinking to evaluate critically current research and/or methodologies in chemistry, develop critiques of them and, where appropriate, adapt them in the context of both advanced scholarship and industrial/business/commercial/professional relevance.

Experimentation:
Working knowledge of a variety of experimental, computational and/or theoretical techniques applicable to current research within chemistry.
Experimental, computational and/or theoretical skills showing the competent use of specialised equipment or techniques, the ability to identify appropriate pieces of equipment and to master new techniques and equipment.

Planning:
Problem-solving skills, in the context of both problems with well-defined solutions and especially the challenges associated with open-ended problems.
The ability to plan an experiment or investigation under supervision, including consideration of the appropriate data analysis (errors, statistical significance, etc.) which will be required.
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.

Securing and analysing data:
The systematic, careful and reliable recording of experimental/computational data or derivation of theoretical results.
An ability to 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 (statistical) significance of their results in this context where appropriate.

Communication:
An ability to communicate complex scientific ideas, the premises and conclusion of an experiment, investigation or project concisely, accurately and informatively, both orally and in writing, to specialist and non-specialist audiences.
An ability to present and interpret information using traditional and/or contemporary methods of dissemination (such as graphics static/animation etc.)

The intended generic learning outcomes. On successfully completing the module students will be able to:
An independent learning ability: to use initiative, to organise oneself to meet deadlines and to interact constructively with people including those from other disciplines.
Self-direction and originality in tackling and solving problems, working effectively both individually and in teams at a professional level, making informed judgements in the absence of complete data.

Method of Assessment

Assignment (microreview) (5 pages, 15%)
Assignment (project report) (50 pages, 40%)
Supervisor assessment (15%)
Presentation (20 mins, 15%)
Viva (20 mins, 15%)

Preliminary Reading

Appropriate learned journals and texts as set by project supervisor and sourced by student
Whitesides Group: Writing a Paper Adv. Mater. 2004, 16, 1375-1377
How to Write and Publish a Scientific Paper, R. A. Day, Greenwood Press, 1998, ISBN: 1573561657
Demystifying Masters Dissertations, A Guide to Producing a Successful Dissertation, D.M. Moore and D.S. Wright, Cranfield University, 2002, ISBN: 861940882
A Handbook of Writing for Engineers J. Van Emden, Macmillan, 1998, ISBN: 0333728076
Writing Successfully in Science, M. O'Connor, Spon, 2002, ISBN: 0419252401

Pre-requisites

Successful completion of Stage 3 of the Chemistry Programme to threshold required for progression into Stage 4.

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, level of effort, etc. appropriate for the level), the preparation of a written report, an oral presentation, and a viva voce examination session. The composition of a micro review on a topic of the student's choice will round-off their skills through critical analysis of the academic literature.

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.

CH741 Computational Chemistry

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	M	15 (7.5)	50% Coursework, 50% Exam	

Availability

This is not available as a wild module

Contact Hours

Total contact hours: 72
Private study hours: 78
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Provide a critical understanding of the field of computational chemistry.
Show how computational chemistry can provide unique insight to complement experimental chemistry.
Show how computational chemistry can deliver understanding in areas that are not, thus far, accessible to experiment.
Understand methods of computational chemistry in depth, spanning hierarchical length and time scales including: quantum mechanical, molecular dynamics (atomistic), mesoscale modelling and molecular graphics.
Use computational methods to calculate the structure, properties and processes of materials.
Evaluate computational chemistry critically with regards to scope and limitations.
Plan, design and formulate a simulation (or set of simulations) that realise a truly predictive capability.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
Effective research costing and planning (health and safety, ethics); 'simulation vs experiment'.
Problem-solving skills, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working.
Interpersonal skills, relating to the ability to engage with others and to engage in team working within a professional environment.
The ability to exercise initiative and personal responsibility. The ability to make decisions in 'unchartered', complex and unpredictable situations. Independent learning ability required for continuing professional development.

Method of Assessment

Practical 1 (20%) Report containing around 3,000 words
Practical 2 (20%) Report containing around 3,000 words
Assignment (10%) Poster
Examination (50%) 3hrs written exam

Preliminary Reading

P.W Atkins, Physical Chemistry, Oxford University Press, 1998, ISBN 0198501013
R. Chang, Physical Chemistry for the Chemical and Biological Sciences, Sausalito, California: University Science Books, 2000, ISBN 9781891389061
Handbook of Computational Chemistry Springer eBooks, Heidelberg, Germany: Springer-Verlag Berlin Heidelberg, 2012, ISBN: 978-94-007-0710-8 (Print) 978-94-007-0711-5 (Online)
Relevant reviewed scientific journals

Pre-requisites

Prerequisite:
Successful completion of Stage 3 of the Chemistry Programme to threshold required for progression into Stage 4

Synopsis *

This module will introduce the student to the growing field of computational chemistry and its viability as a cost effective alternative to experiment that provides unique insight. It is critically important that an MChem student is trained in this area because many peer reviewer publications in physical, inorganic and organic chemistry include a computational component. The module will run primarily as a set of computational labs with lectures delivering the understanding, background and application of the methods used in the laboratory sessions including:

Classical Mechanics:
Atomistic Simulation, Force-fields, Energy Minimisation, Molecular Dynamics, Monte Carlo

Quantum Mechanics:
Density Functional Theory, Hartree-Fock theory, Wave-Function mechanics

Simulation Codes:
Examples may include for example: DL_POLY, GULP (classical mechanics), Gaussian, Castep, Dmol (quantum mechanics)

The experiments will cover the use of computer modelling to explore the structure, properties, processes and applications of organic and inorganic materials. Typically, they might comprise:
• Simulating the adsorption of molecules on surfaces (catalysis).
• Calculating the density of states and phonon modes of materials (band gap).
• Calculating activation energy barriers of a chemical reaction (organic chemistry).
• Simulating diffusion processes (fuel cells, battery materials).
• Simulating (hard, soft) systems at the mesoscale, such as surfactant-polymer interactions and architectures.
• Quantitative Structure – Activity Relationship (QSAR) models; the application of descriptor calculations and statistical modelling to design new molecules.
• Machine Learning – intelligent computer-aided design of new materials.

The final experiment (mini project) will be one of the students own choosing where they will plan, design and formulate a computational experiment using any computational method available and then appraise the reliability and intellectual or commercial value of the experiment.

PH500 Physics Laboratory

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 57
Private study hours: 243
Total study hours: 300

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assessment 1: (Laboratory book and 3000 word report, 12.50 %)
Assessment 2: (Laboratory book and 3000 word report, 12.50 %)
Assessment 3: (Laboratory book and 3000 word report, 12.50 %)
Written Communication: (2 pages + reference list, 6.25%)
Oral Communication: 6.25%
Assessment 4: (Laboratory book and 3000 word report, 16.60%)
Assessment 5: (Laboratory book and 3000 word report, 16.70%)
Assessment 6: (Laboratory book and 3000 word report, 16.70%)

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 (1997)

Pre-requisites

None.

Synopsis *

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 including communication to a non-specialist audience.

PH502 Quantum Physics

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

Availability

This not available as a wild module.

Contact Hours

Total contact hours: 40
Private study hours: 110
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Display knowledge and understanding of physical laws and principles in Quantum Physics, and their application to diverse areas of physics.
Display an ability to identify relevant principles and laws when dealing with problems in Quantum Physics, and to make approximations necessary to obtain solutions.
Display an ability to solve problems in Quantum Physics using appropriate mathematical tools.
Display an ability to use mathematical techniques and analysis to model physical behaviour in Quantum Physics.
Display an ability to present and interpret information graphically.
Display an ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Display problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
Display 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

Problem sheet 1 (10 hours, 15%)
Problem sheet 2 (10 hours, 15%)
Exam 70% - 2 hours

Preliminary Reading

Quantum Mechanics – Bransden, B. H., Joachain, C. J., 2000
Quantum Mechanics: Concepts and Applications – Zettili, Nouredine, 2009
Introduction to the Structure of Matter – Brehm, John J., Mullin, William J., 1989
Quantum Mechanics – Rae, Alastair I. M., c2008
Feynman Lectures in Physics – Vol. 3
The Theoretical Minimum: Quantum Mechanics – Leonard Susskind & Art Friedman (Penguin Books 2014)

Pre-requisites

None.

Synopsis *

This module provides an introduction to quantum mechanics, developing knowledge of wave-functions, the Schrodinger equation, solutions and quantum numbers for important physical properties. Topics include: 2-state systems. Bras and kets. Eigenstates and Eigenvalues; Superposition Principle; Probability Amplitudes; Change of Basis; Operators. The Schrodinger equation. Stationary states. Completeness. Expectation values. Collapse of the wave function. Probability density. 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. Atomic vibrations.

PH503 Atomic Physics

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

Total contact hours: 32
Private study hours: 118
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of physical laws and principles in Quantum and Atomic Physics, and their application to diverse areas of physics
Identify relevant principles and laws when dealing with problems in Quantum and Atomic Physics, and to make approximations necessary to obtain solutions.
Solve problems in Quantum and Atomic Physics using appropriate mathematical tools.
Use mathematical techniques and analysis to model physical behaviour in Quantum and Atomic Physics.
To present and interpret information graphically.
To make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Use problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems.
Numeracy is subsumed within this area.
Demonstrate 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 hrs) 30%, consisting of
Homework 1 (10 hours, 15%)
Homework 2 (10 hours, 15%)
Exam (2 hours) 70%

Preliminary Reading

Quantum mechanics - Bransden, B. H., Joachain, C. J. 2000
Introduction to the Structure of Matter – Brehm, J.J. and Mullin, W.J. 1989
Atomic Physics – Jones, D.G.C. 1997

Pre-requisites

PH502 – Quantum Mechanics
PH588 – Maths
PH504 - Electromagnetism

Synopsis *

This module will build on the general principles of quantum mechanics introduced earlier in the degree and applied them to the description of atoms, starting by the description of the hydrogen atom and covering other topics such as the effect of magnetic fields on an atom or X-ray spectra.

PH504 Electromagnetism and Optics

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 36
Private study hours: 114
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of physical laws and principles in Electromagnetism and Optics, and their application to diverse areas of physics.
Demonstrate an ability to identify relevant principles and laws when dealing with problems in Electromagnetism and Optics, and to make approximations necessary to obtain solutions.
Demonstrate an ability to solve problems in Electromagnetism and Optics using appropriate mathematical tools.
Demonstrate an ability to use mathematical techniques and analysis to model physical behaviour in Electromagnetism and Optics.
Demonstrate an ability to present and interpret information graphically.
Demonstrate an ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate a knowledge and understanding of 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.
Demonstrate a knowledge and understanding of 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 (20 hrs) 30%, consisting of
Homework 1 (10 hours, 15%)
Homework 2 (10 hours, 15%)
Exam (2 hours) 70%

Preliminary Reading

D.J. Griffiths, Introduction to Electrodynamics, 3rd Ed. (1999), Prentice Hall
Tipler, P. A., Physics, 4th Ed., W.E. Freeman
E Hecht, Optics, 2nd Ed. (1987), Addison-Wesley

Pre-requisites

Prerequisite:
PHYS3210 Mechanics
PHYS3220 Electricity and Light
PHYS3230 Thermodynamics and Matter

Synopsis *

This module looks to introduce a range of important laws and principles relating to the physics of electromagnetism and optics. Students will also learn mathematical techniques to enable the modelling of physical behaviour and apply important theory to a range of electromagnetism and optics scenarios.

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 36
Private study hours: 114
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of physical laws and principles of astronomy, astrophysics and space science, and their application to diverse areas of physics.
Demonstrate 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.
Identify relevant principles and laws when dealing with problems in astronomy, astrophysics and space science, and to make approximations necessary to obtain solutions.
Solve problems in astronomy, astrophysics and space science using appropriate mathematical tools.
Use mathematical techniques and analysis to model physical behaviour within astronomy, astrophysics and space science.
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.
Present and interpret astronomical, astrophysical and space science information graphically.
Make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Solve problems, 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.
Use 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

Take-home Test 1 (10 hrs, 15%)
Take-home Test 2 (10 hrs, 15%)
Examination (2hrs, 70%)

Preliminary Reading

An Introduction to Modern Astrophysics (Jul 2013), by Bradley W. Carroll and Dale A. Ostlie,
Berry, Principles of Cosmology and Gravitation, Adam Hilger [QB891]
Roos, Introduction to Cosmology, Wiley [QB891]
Cosmological Physics; Peacock, J.A (1999)

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 Stage 1, and to consider evidence for the existence of exoplanets in other Solar Systems.

Telescopes and detectors:
Radio telescopes; detection of radio waves, heterodyne receivers, bolometers; Optical/NIR Telescopes and detectors; basic band gap theory; CCD cameras; bias, dark and flatfield calibration frames and data reduction; Stellar Photometry: Factors affecting signal from a stars; atmospheric absorption and scattering; Filters; UBV system; Colour Index as temperature diagnostic.

Basic stellar properties:
Mass measurements: Kepler's laws; solar system; binary stars; Visual binaries; Eclipsing binaries, Spectroscopic binaries; Introduction to the Hertzsprung-Russel diagram; spectroscopic parallax Introduction to star formation: Molecular clouds; Jeans criterion for collapse; Protostars; T-Tauri stars; Contraction onto the Main Sequence; Heyney and Hayashi Tracks; Stellar spectral classification: Basic stellar properties; back body radiation; stellar spectra; radiative transfer in stellar atmospheres

Stellar Structure:
equation of hydrostatic support; Virial theorem; central pressure; mean temperature; astrophysical time scales; equations of energy generation and transportation; convective vs radiative energy transport;

Extra Solar Planets
Detection Methods; Direct Detection; Radial velocity technique; Transit method; Microlensing and direct imaging; the population of exoplanet systems, Metallicity, Eccentricity, Core Accretion and Gravitational Instability

Galaxies:
Introduction to Galaxies; Hubble classification; the Milky Way; Spirals; Dark matter; Ellipticals; Irregulars; luminosity functions; Galaxy Clusters, distributions and physical processes; The Hubble Constant, Evolution, Mergers, Star Formation History; Quasars, Seyferts and Radio Galaxies

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 32
Private study hours: 118
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of physical laws and principles, and their application to diverse areas of physics focussed on spacecraft design and operations.
Demonstrate 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.
Demonstrate an ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions relevant to spacecraft science.
Demonstrate an ability to solve problems in physics using appropriate mathematical tools.
Demonstrate an ability to use mathematical techniques and analysis to model physical behaviour.
Demonstrate 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.
Demonstrate an ability to use mathematical techniques and analysis to model physical behaviour.
Demonstrate an ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

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

Test 1 (10hours, 15%)
Test 2 (10hours, 15%)
Examination (70% - 2 hours)

Preliminary Reading

Recommended texts:
Fortescue, Stark and Swinerd, Spacecraft Systems Engineering, Wiley (2003). [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 *

This module aims to provide a basic understanding of the major subsystems of a spacecraft system and the frameworks for understanding spacecraft trajectory and orbits, including interplanetary orbits, launch phase and altitude control. Students will also gain an awareness of ideas on how space is a business/commercial opportunity and some of the management tools required in business.

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	
1 Canterbury	Spring	I	15 (7.5)	100% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours (Presentation and workshop-style tutoring during scheduled sessions: not including office contact hours): 33
Private study hours: 117
Total study hours: 150

Learning Outcomes

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

Other more specific learning outcomes:
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.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assignment 1 (1,400-1,600 words) – 25%
Assignment 2 (1,400-1,600 words) – 25%
Assignment 3 (1,400-1,600 words) – 25%
Assignment 4 (1,400-1,600 words) – 25%

Preliminary Reading

The Handbook of Astronomical Image Processing [with cd-rom] (2nd Edition); Berry, R. & Burnell, J. (2005)

Pre-requisites

None

Synopsis *

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 36
Private study hours: 114
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes.On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assignment 1 (25%) on non optics techniques in two stages: a Moodle quiz of 20 minutes (10%), and a Moodle quiz of 30 minutes (15%), with access to the lecture notes;
Assignment 2 on optics techniques (5%), Moodle quiz, 10 minutes, access to the lecture notes
Examination (70%), 2 hours

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

PHYS3210 Mechanics
PHYS3220 Electricity and Light
PHYS3230 Thermodynamics and Matter
PHYS5040 Electromagnetism and Optics

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 a major contribution from the professional medical physicist.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assessment 1: (Laboratory book and 3000 word report, 25 %)
Assessment 2: (Laboratory book and 3000 word report, 25 %)
Assessment 3: (Laboratory book and 3000 word report, 25 %)
Written Communication: (2 pages + reference list, 12.5%)
Oral Communication: 12.5%

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 (1997).

Pre-requisites

None.

Synopsis *

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 including communication to a non-specialist audience.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 36
Private study hours: 114
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Solve problems in physics using appropriate mathematical tools.
Present and interpret information graphically.
Make use of appropriate texts, or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Formulate problems in precise terms and to identify key issues, and have the confidence to try different approaches in order to make progress on challenging problems. Numeracy is subsumed within this area.
Pay attention to detail and manipulate precise and intricate ideas.
Construct logical arguments and use technical language and demonstrate numeracy.

Method of Assessment

Problem Solving 1 (10 hour 15%)
Problem Solving 2 (10 hour 15%)
Exam (2 hours 70%)

Preliminary Reading

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

Suggested additional reading:
Introduction to Mathematical Physics by Chun Wa Wong, Oxford University Press (2013)
Mathematics for Physics by M M Woolfson and M S Woolfson, Oxford University Press (2007)
E. Kreyszig, Advanced Engineering Mathematics, John Wiley and sons (2011)
W. Bolton, Fourier Series, Longman Technical (1994)

Pre-requisites

Prerequisites:
PHYS3110 Mathematics I
PHYS3120 Mathematics II

Synopsis *

The module will 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.

PH590		Year in Industry				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	120 (60)	100% Project	

Availability

This is not available as a wild module.

Contact Hours

Provided by the industrial partner. Includes typical methods of bibliographic study, taking part in meetings and working on a variety of research areas in a commercial environment. Should be equivalent to 1200 total study hours at University of Kent.

Learning Outcomes

During their placement, students will learn to apply the knowledge, understanding and skills they have developed during the earlier stages of their programme to "real world" tasks in an industrial or commercial setting.

The intended generic learning outcomes
Note that it is only necessary to meet a majority of these learning outcomes, because all learning outcomes are also provided in Stage 1, 2 or 3 of the programme.

Transferable skills:
Problem-solving skills
Investigative skills
Communication skills
Analytical skills
Personal skills

Method of Assessment

The assessment of the Year in Industry module counts towards both the progression of students on the BSc in Physics with a Year in Industry programme and their eventual classification.

The assessment of the Year in Industry module is based on three components:
A mark for the contribution provided by the student to the activities of the Industrial partner. This mark will be attributed at the end of the industrial placement by the School's industrial liaison team in consultation with the industrial partner's designated liaison.(weighted at 40%)
A report (approximately 5,000 words) on the student's educational experience prepared by the student on their return as well as documentary evidence of a portfolio of work which the student acquires during their placement year which includes projects the have been involved in. This portfolio provides evidence of student educational attainment during the placement year. (weighted at 40%)
A talk given by the student on their return to the University of Kent in Stage 3 – to be considered by the School's industrial liaison team. (weighted at 20%)

Preliminary Reading

Provided by the industrial partner.

Pre-requisites

None. Placement is to be confirmed by the designated academic liaison.

Synopsis *

PH590 is intended to offer the students an insight into the application of Physics in an industrial environment.
With regards to placements, the designated academic liaison will check and approve the student's activities at the time they are at the site of the industrial partner.

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	
1	Canterbury	Autumn	H	15 (7.5)	60% Exam, 40% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 20
Private study hours: 130
Total study hours: 150

Learning Outcomes

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

Demonstrate an assured ability to identify relevant principles and laws when dealing with physics problems, and to make approximations necessary to obtain solutions.
Confidently solve problems in physics using appropriate mathematical tools.
Demonstrate competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information for problem solving.
Present and interpret scientific information graphically to solve complex problems.
Communicate scientific information about problem solving, in particular to produce clear and accurate scientific reports.
Demonstrate an ability to make use of appropriate physics-based texts, research-based materials or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate comprehensive 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.
Demonstrate 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.
Demonstrate the ability to work independently, to use initiative, to organise oneself to meet deadlines.

Method of Assessment

Assignment 1 (10 hours) – 20%
Assignment 2 (10 hours) – 20%
Examination (3 hours) – 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 *

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.
Problems are presented and solutions discussed in topics spanning several topics in the undergraduate physics curriculum (Mechanics and statics, thermodynamics, and optics, 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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 56
Private study hours: 94
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate an ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
Demonstrate an ability to present and interpret information graphically.
Demonstrate an ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
Demonstrate an ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of 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.
Demonstrate knowledge and understanding of 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.
Show 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.
Demonstrate knowledge and understanding of 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.
Show 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

Assignment – report, 10,000 words (50%)
Assignment – poster (10%)
Presentation – 30 minutes (30%)
Performance – intra-group peer assessment (10%)

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 *

This module provides an opportunity for students to work in groups to tackle open ended research problems. Project themes vary from industry linked projects to academic research and education/outreach projects. Students develop a variety of presentation skills and team work within the module as well as open ended project work.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Take-home Test 1 (45 mins, 15 %)
Take-home Test 2 (45 mins, 15 %)
Examination (70%)

Preliminary Reading

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
Edwin F. Taylor and John Archibald Wheeler, Spacetime Physics: Introduction to Special Relativity, 2nd ed. W. H. Freeman & Company, 1992.

Pre-requisites

PHYS3010 Physics
Or replacement modules
PHYS3210 Mechanics
PHYS3220 Electricity and Light
PHYS3230 Thermodynamics and Matter
And
PHYS5040 Electromagnetism and Optics

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Take-home test 1 (10 hour, 15%)
Take-home test 2 (10 hour, 15%)
Examination (2 hours 70%)

Preliminary Reading

Statistical Physics - A. M. Gue´nault
Statistical Physics - F. Mandl
Thermal physics - Baierlein, Ralph

Pre-requisites

Prerequisites:
PHYS3000 Mathematics
PHYS3010 Physics
PHYS5020 Quantum Physics
PHYS5030 Atomic Physics

Synopsis *

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.

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.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 27
Private study hours: 123
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assignment 1: (10hours, 15%)
Assignment 2: (10hours, 15%)
Examination (2 hour, 70%)

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

Prerequisites:
PHYS3210 Mechanics
PHYS3230 Thermodynamics and Matter
PHYS5020 Quantum Physics

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of physical laws and principles of astrophysics, and their application to diverse areas of physics.
Identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
Solve problems in physics involving stars and galaxies using appropriate mathematical tools.
Use mathematical techniques and analysis to model physical behaviour of stars and galaxies and the universe.
Present and interpret information about stars and galaxies graphically.
Make use of appropriate texts, research-based materials or other learning resources about astrophysics as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Solve problems, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area.
Use 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

Test 1 (3 hours,15%)
Test 2 (3 hours,15%)
Examination (2 hours, 70%)

Preliminary Reading

Carroll & Ostlie, Modern Astrophysics, Addison Wesley, 2013
Bohm-Vitense, Volume 3; Stellar Structure and Evolution, Cambridge University Press, 1992
Taylor, The stars: Their structure and Evolution, Cambridge University Press, 2010
Berry, Principles of Cosmology and Gravitation, Adam Hilger, 1989
Roos, Introduction to Cosmology, Wiley, 2015
Peacock, Cosmological Physics, Cambridge University Press, (1999)
Rowan-Robinson, Cosmology, OUP, 2004

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.

Physics of Stars
equations of state for an ideal multiple chemical component star; degenerated stars, Nuclear reactions: PPI, PPII, PPIII chains; CNO cycle, Triple-alpha process; elemental abundances; energy transportation inside a star; derivation of the approximate opacity and energy generation models as function of density, temperature and chemical components; Solar neutrino problem; polytropic models applied to the equations of stars; Lane-Emden equation; Chandrasekhar mass; the Eddington Luminosity and the upper limit of mass; detailed stellar models; Post main sequence evolution of solar mass stars; Red Giants; White Dwarfs; Neutron Stars; Degenerate matter; properties of white dwarfs; Chandrasekhar limit; neutron stars; pulsars; Supernovae

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; Einstein Rings, black holes, gravitational waves; Brief survey of the universe; Olbers paradox, Cosmology, principles, FRW Metric, Laws of Motion & Distances, Friedmann equation, Scale Factor, Fluid equation, The Hubble Parameter, Critical Density parameter, Cosmological Constant parameter, Radiation-Matter-Dark Energy phases; The CMB, Temperature Horizons. Monopoles. Flatness problem. Hubble sphere, Inflation, Anisotropies, Polarisation Baryon Acoustic Oscillations, Secondary anisotropies; Baryosynthesis, Nucleosynthesis, Dark Matter observations, Lensing, Bullet Cluster, Dark Matter candidates, Cosmic Distance Ladder, Redshifts Galaxy surveys; Acceleration equation, Deceleration equation, Supernova as standard candles, Dark Energy, Einstein Field equations, Coincidence problem, The Cosmic Dark Ages & AGN Reionisation, High-z galaxies

PH608 The Sun, The Earth and Mars

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assessment 1 - 15% (10 hours)
Assessment 2 - 15% (10 hours)
Examination - 70% (2 hours)

Preliminary Reading

Core:
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

Prerequisites:
PHYS5080 Spacecraft Design and Operations

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	
1	Canterbury	Spring	H	15 (7.5)	100% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 32
Total Private Study Hours: 118
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate the ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
Demonstrate a systematic ability to solve problems in physics using appropriate mathematical tools.
Demonstrate a confident ability to use mathematical techniques and analysis to model physical behaviour.
Demonstrate an assured 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.
Demonstrate the ability to accurately interpret mathematical descriptions of physical phenomena.
Display a working knowledge of a variety of mathematical and/or computational techniques applicable to current research within physics.
Demonstrate complete competence in the use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
Present and interpret information graphically accurately and confidently.
Demonstrate the ability to make use of appropriate texts, or other learning resources as part of managing their own learning.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate extensive 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.
Demonstrate professional 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

Problem Sheet 1 (3 hours) – 20%
Problem Sheet 2 (3 hours) – 20%
Problem Sheet 3 (3 hours) – 20%
Problem Sheet 4 (3 hours) – 20%
Problem Sheet 5 (3 hours) – 20%

Preliminary Reading

Chapra, S. (2008). Applied Numerical Methods with MATLAB for Engineers and Scientists. New York: McGraw-Hill.
Moler, C. (2004). Numerical Computing with MATLAB, Society for Industrial and Applied Mathematics, Philadelphia: SIAM.

Pre-requisites

None

Synopsis *

This module provides a foundation in numerical approximations to analytical methods – these techniques are essential for solving problems by computer. An indicative list of methods is: 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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 55
Private study hours: 95
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Practical (16.7% - max. 10 pages)
Practical (16.7% - max. 10 pages)
Practical (16.6% - max. 10 pages)
Assignment (50% - max. 25 pages)

Preliminary Reading

An Introduction to Error Analysis; Taylor, J.R. (1997)
Writing for Science and Engineering: Papers, Presentations and Reports; Silyn-Roberts, H. (2013)
Scientists Must Write; Barrass, R. (2002)

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

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Take Home Test 1 (2 Hours, 15%)
Take Home Test 2 (2 Hours, 15%)
Examination (2 hours, 70%)

Preliminary Reading

Fundamentals of digital image processing: a practical approach with examples in Matlab, Solomon, Chris, Breckon, Toby 2011, Wiley Blackwell, ISBN 0470844736
Gonzalez and Woods, Digital Image Processing, Addison-Wesley, 1992, ISBN 0-201-50803-6
John C. Russ, The Image Processing Handbook, CRC Press, 1995
Matlab: A Practical Introduction to Programming and Problem Solving, Stormy Attaway, Elsevier, 2018, ISBN: 9780128154793

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 40
Private study hours: 560
Total study hours: 600

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Project progress (i.e. supervisor assessment of performance) (15%)
Project report (55%), max. 12,000 words
Viva voce (15%)
Presentation (15%), duration 15 minutes

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours (Lectures and workshop sessions – does not include office contact hours): 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

Other more specific learning outcomes:
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.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Two homework assignments (15% each) (10 hours each)
Examination (2 hours, 70%)

Preliminary Reading

Wertz and Larson, Space Mission Analysis and Design, 3rd Edition, 1992 [TL 790]
Jones, Discovering the Solar System, 2nd Edition, 1999 [q QB501]
Taylor, Solar System Evolution, 2nd Edition, 2001 [q QB501]
Fortescue, Stark and Swinerd, Spacecraft Systems Engineering, 3rd ed, Wiley, 2003 [TL875]

Other reading:
Davies; Astronomy from Space: The Design and Operation of Orbiting Observatories, Wiley,1997 [QB136]
Encrenaz, Bibring and Blanc; The Solar System, Springer, 2010 [QB 501]
Jakosky: The Search for Life on Other Planets, 1998 [QB 54]
Gilmour & Sephton: Introduction to Astrobiology, 2004 [qQB 501]
Carroll and Ostlie, Modern Astrophysics, 2nd Edition, 2007 (copies of the 1st edition are in the library at QB461)

Pre-requisites

None.

Synopsis *

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours (Lectures and workshop sessions – does not include office contact hours): 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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.

Other more specific learning outcomes:
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 astronauts.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Two homework assignments (15% each, 10 hours each)
Examination (2 hours, 70%)

Preliminary Reading

Recommended Text:
Fortescue, Stark and Swinerd, Spacecraft Systems Engineering, 3rd ed, Wiley, 2003 [TL875, 6 copies]
Wertz and Larson, Space Mission Analysis and Design, 3rd Edition, 1999 [TL 790]
Sutton, Rocket Propulsion Elements, 1992 [TL 782]
Sidi, Spacecraft Dynamics and Control, 1997 [TL 1050]

Background reading (In addition, a fuller reading list will be distributed in the lectures):
McNamara: Into the Final frontier, Harcourt, 2000 [qTL873]
Nicogossian, Huntoon and Pool: Space Physiology and Medicine, Lea & Febiger, 1994 [RC1150]
Turner: Rocket and Spacecraft Propulsion, Praxis, 2000 [TL782]

Pre-requisites

Prerequisite:
PHYS5080 Spacecraft Design and Operations

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.

PH712 Cosmology and Interstellar Medium

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have:
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.
A systematic understanding of most fundamental laws and principles of physics and of astronomy, astrophysics and space science, along with their application – some of which are at (or are informed by) the forefront of the discipline.
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 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 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 experimental, mathematical and/or computational techniques applicable to current research within physics.
An enhanced ability to work within in the astronomy, astrophysics and space science areas 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 or other learning resources as part of managing their own learning.
An ability to make use of research articles and other primary sources.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Take-home Test 1 (10 hrs, 15%)
Take-home Test 2 (10 hrs, 15%)
Examination (70%, 2hrs)

Preliminary Reading

The Physics of the Interstellar Medium; Dyson, J.E. & Williams, D.A (1997)
Cosmological Physics; Peacock, J.A (1999)
Cosmology; Rowan-Robinson, M (1997)
Astrophysics vol.2; Bowers, R.L. & Deeming, T (1994)
Annual Reviews of Astronomy and Astrophysics, 30, 499-542; Carroll, Press & Turner (1992)

Pre-requisites

Prerequisites:
PHYS5030 Atomic Physics
PHYS5070 The Multiwavelength Universe and Exoplanets
PHYS6070 Stars, Galaxies and the Universe

Synopsis *

Interstellar Medium:
The major properties of the Interstellar Medium (ISM) are described. The course will discuss the characteristics of the gaseous and dust components of the ISM, including their distributions throughout the Galaxy, physical and chemical properties, and their influence the star formation process. The excitation of this interstellar material will be examined for the various physical processes which occur in the ISM, including radiative, collisional and shock excitation. The way in which the interstellar material can collapse under the effects of self-gravity to form stars, and their subsequent interaction with the remaining material will be examined. Finally the end stages of stellar evolution will be studied to understand how planetary nebulae and supernova remnants interact with the surrounding ISM.

Extragalactic astrophysics:
Review of FRW metric; source counts; cosmological distance ladder; standard candles/rods.
High-z galaxies: fundamental plane; Tully-Fisher; low surface brightness galaxies; luminosity functions and high-z evolution; the Cosmic Star Formation History
Galaxy clusters: the Butcher-Oemler effect; the morphology-density relation; the SZ effect
AGN and black holes: Beaming and superluminal motion; Unified schemes; Black hole demographics; high-z galaxy and quasar absorption and emission lines.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have:
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 and solve them.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have the knowledge and understanding of:
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

Assignment 1 (10hour, 15%)
Assignment 2 (10hour, 15%)
Examination (70%)

Preliminary Reading

B. R. Martin, Nuclear and Particle Physics, Wiley (2006)
Bettini, Introduction to Elementary Particle Physics (QC794.6.575)
S. McMurry, Quantum Mechanics, Prentice-Hall (1993)
M. Thomson, Modern Particle Physics (2013)
F. Mandl, Quantum Mechanics, Wiley (1992)

Pre-requisites

Prerequisites:
PHYS5020 Quantum Physics
PHYS5030 Atomic Physics

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 diffraction 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

Total contact hours: 0
Private study hours: 150
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have:
An appreciation of the "state of the art" in a chosen focussed 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.

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

Assignment (80%)
Presentation (20%)

Preliminary Reading

Journal: Reviews of Modern Physics (American Physical Society)
Journal: Reports on Progress in Physics (Institute of Physics)
Journal: Condensed Matter Physics: Eds Seitz, Turnbull and Ehrenreich (Academic Press)
Journal: Astronomy and Astrophysics Review (Springer)

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assignment (15%)
Assignment (15%)
Examination (70%)

Preliminary Reading

S. Blundell; Magnetism in Condensed Matter (2001).
J. F. Annett; Superconductivity, Superfluids and Condensates (2004).
R. M. White; Quantum theory of magnetism: magnetic properties of materials (2010).
P. G. de Gennes; Superconductivity of Metals and Alloys (1999).

Pre-requisites

Prerequisite: PHYS6060 Solid State Physics.

Synopsis *

Introduction. Magnetism, magnetometry and measuring techniques, Localised 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. 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.

PH790 Year Abroad

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	120 (60)	Pass/Fail Only	
1	Canterbury	Whole Year	H	120 (60)	100% Project	

Availability

This is not available as a wild module.

Contact Hours

Provided by department at the university abroad. Includes typical methods of lectures, homework, and laboratory work. Should be equivalent to 1200 total study hours at University of Kent.

Learning Outcomes

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

Knowledge and understanding of:
Physical laws and principles, and their application to diverse areas of physics.
Aspects of theory and practice of physics, physics with astrophysics, or astronomy, astrophysics and space science.

Intellectual skills:
An ability to identify relevant principles and laws, and to make approximations 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.
An ability to use mathematical techniques and analysis to model physical behaviour.
An ability to plan an experiment or investigation under supervision.

Subject-specific skills:
Competent use of appropriate C&IT packages/systems for the analysis and the retrieval of appropriate information.
An ability to present and interpret information graphically.
An ability to communicate scientific information.
A familiarity with laboratory apparatus and techniques.
The systematic and reliable recording of experimental data.
An ability to make use of appropriate texts, research-based materials or other learning resources.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of: Transferable skills:

Problem-solving skills
Investigative skills
Communication skills
Analytical skills
Personal skills

Method of Assessment

Pass/fail

Preliminary Reading

Provided by department at the university abroad.

Pre-requisites

Must reach threshold of 60% (overall average) in Stage 1 at first attempt (with no compensation or condonement of Stage 1 modules). Must reach threshold of 60% (overall average) in Stage 2 at May exams. (This deadline is necessary due to the time required to arrange an exchange placement in the following months.) Must properly complete placement procedure supervised by International Office.

Synopsis *

PH790 needs to cover a majority of learning outcomes in Stage 3 of the parent MPhys programme. The modules in the university abroad should normally cover similar topics at a similar level. Note that a one-to-one correspondence is not feasible and would negate the purpose of the Year Abroad, which is to provide the student with the experience of the educational system abroad. In addition, the student has the opportunity to study some modules which are not available at University of Kent.
With regards to topics, the academic liaison (typically DoUGS Physics) will check and approve the students choice of modules at the time they are at the university abroad.

PS501 Forensic Physical Methods

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	50% Coursework, 50% Exam	
1	Canterbury	Whole Year	I	15 (7.5)	100% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total Contact Hours: 50
Total Private Study Hours: 100
Total Study Hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Understand the role of physical forensic methods in forensic practice.
Demonstrate knowledge and critical awareness of the major physical forensic methods.
Display understanding of emerging developments in forensic science.
Assess, manage, and investigate a range of incident scenes
Recover, preserve, package and document evidential samples from a range of incident scenes to professional standards.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Understand the key areas of science and law that underpin forensic practice and methodology.
Understand the science and scientific methods underpinning forensic investigation and recovery of evidence.
Communicate complex scientific and forensic findings to a lay audience in written form.
Use problem solving, and information retrieval and handling.
Use team working and time management skills, and skills relevant to further study.

Method of Assessment

Online Quiz 1 (1 hour) – 15%
Online Quiz 2 (1 hour) – 15%
Case File – 70%
The online quizzes are compulsory sub-components and at least one must be passed in order to pass the module.

Preliminary Reading

Bevel, T. and Gardner, R.M. (2008). Bloodstain Pattern Analysis (Third Edition).CRC Press
Dutelle, A.W. (2013). Introduction to Crime Scene Investigation. Jones & Bartlett
Fraser, J. and Williams, R. (2009). Handbook of Forensic Science. London: Routledge
Saferstein, R. (2017). Criminalistics (An Introduction to Forensic Science). Harlow: Person Education, Prentice Hall.
White, P. (2004). Crime Scene to Court. Royal Society of Chemistry

Pre-requisites

None.

Synopsis *

This module will cover the following topics:
Evidential practice and law in relation to location, recovery, preservation, and interpretation of a wide range of forensic samples.
Statement and report writing to evidential standard.
Incident assessment and management in a wide variety of forensic environments.
Location, recovery and preservation of a range of forensic samples.
Incident mapping and photography.
Document and forgery analysis.
Modern and emerging forensic techniques

PS502		Forensic Archaeology				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Spring	I	15 (7.5)	70% Exam, 30% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 22
Private study hours: 128
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge of the principle areas of forensic archaeology including dating, detection and osteology.
Demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to forensic archaeology.
Apply such knowledge and understanding to the solution of problems.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Use problem-solving skills, relating to qualitative and quantitative information.
Apply numeracy and computational skills.

Method of Assessment

Assignment 1 (5 hours, 5%)
Assignment 2 (5 hours, 5%)
Assignment 3 (5 hours, 5%)
Assignment 4 (5 hours, 5%)
Exam (2 hours, 70%)

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
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.
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.

PS504 Study and Employability Skills for Level 5

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	1 (0.5)	Pass/Fail Only	

Contact Hours

Total Contact Hours: 5
Private Study Hours: 5
Total Study Hours: 10

Learning Outcomes

1 Communication and presentation
2 Data analysis
3 Research
4 Self-directed learning
5 Career planning

Method of Assessment

Formative assessment/feedback only.

Preliminary Reading

No formal reading list. Students may be directed to reading materials for specific tutorials

Restrictions

This is not available as an elective module.

Synopsis *

One-on-one meetings and group tutorials focused on academic progression and the development of key skills to support the core curriculum and future study or employment. Students meet with their Academic Advisor individually or in groups at intervals during the academic year. Individual meetings review academic progress, support career planning etc. Themed tutorials develop transferable skills; The tutorials are informal involving student activity and discussion. Year group events deliver general information e.g. on University resources, 4-year programmes, module selection etc.

PS511		Digital Forensics				
Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	I	15 (7.5)	60% Exam, 40% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 40
Private study hours: 110
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a 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 b) using facial composite software
Methods used in digital image forensics and their implementation in 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

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

Assignment 1 (6.6%) 2hr
Assignment 2 (6.6%) 2hr
Assignment 3 (6.7%) 2hr
Lab assignment 4 (6.7%) 2hr
Lab assignment 5 (6.7%) 2hr
Lab assignment 6 (6.7%) 2hr
Examination (60%) 2hr

Preliminary Reading

Crime Scene to Court, The Essentials of Forensic Science, 2nd edition, ed. P. White. Royal Society of Chemistry, 2004. ISBN: 0854046569
Digital Image Processing using Matlab, Gonzalez, Woods and Eddins, Pearson Prentice Hall, 2004
Handbook of Computer Crime Investigation, E. Casey, Academic Press, 2002

Pre-requisites

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

Synopsis *

Facial Identification
Indicative topics are: 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
Indicative topics are: Image formation, image storage, image distortion, image restoration methods, the digital image in crime detection, steganography (implementation and detection).

Digital Forensics
Indicative topics are: 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. Legislation relating to computer misuse.

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	
1	Canterbury	Whole Year	I	15 (7.5)	50% Coursework, 50% Exam	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 47
Private study hours: 103
Total study hours: 150

Learning Outcomes

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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Statistics Assignment – 10.0%
Analytical Skills Assignment – 9.6%
Lab 1 (3 hours) – 3.4%
Lab 2 (3 hours) – 3.4%
Lab 3 (3 hours) – 3.4%
Lab 4 (3 hours) – 3.4%
Lab 5 (3 hours) – 3.4%
Lab 6 (3 hours) – 3.4%
Examination (2 hours) – 60%

Preliminary Reading

Lucy, D. (2005). Introduction to Statistics for Forensic Scientists. Wiley.
Miller, J.N. and Miller, J.C. (2010). Statistics and Chemometrics for Analytical Chemistry, Sixth Edition. Pearson Prentice Hall
Monk, P. and Munro, L.J. (2010). Maths for Chemistry, Second Edition. OUP.
Rowntree, D. (2000). Statistics Without Tears. Penguin.
Scott, S.K. (1995). Workbooks in Chemistry Beginning Mathematics for Chemistry. OUP.
Spiegel, M.R. (2013). Schaum's Outline of Probability and Statistics, Fourth Edition. McGraw Hill.

Pre-requisites

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

Synopsis *

This module will cover the following topics:

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.

PS534 Inorganic Chemistry, Fibres and Microscopy

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 41
Private study hours: 109
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Understand the characteristic properties of the d and f-blocks elements and their compounds.
Appreciate developments at the forefront of some areas of Forensic Science, particularly, developments in the structure and bonding in inorganic matter and how this relates to atomic analysis, and separately, developments in fibre and paper analysis which includes polarised light microscopy.

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. In particular, the ability to link chemical structure to reaction compatibility and further to link reaction sequences.
Ability to recognise and analyse problems and plan strategies for their solution by the evaluation, interpretation and presentation of scientific information and data.
Ability to recognise and implement good measure science and practice and commonly used forensic laboratory techniques.

Subject-specific skills:
A knowledge and understanding of the d-block elements and f-block elements and their compounds.
A knowledge and understanding of materials from which fibres and paper are derived, and of fibre structure and techniques used in comparative analysis of these materials for forensic assessment.
An understanding of preparation, purification and analysis of a range of inorganic compounds using techniques such as ion-exchange chromatography, infra-red and uv-vis spectroscopy relevant to forensic investigation.
An ability to make use of appropriate texts, or other learning resources as part of managing their own learning.
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, and the ability to implement the execution of experiments.
Skills required for carrying out documented standard laboratory procedures involved in synthetic and analytical work in relation inorganic systems and forensic analysis. Skills in observational and instrumental monitoring of physiochemical events and changes. The systematic and reliable documentation of the above. Operation of standard analytical instruments employed in the chemical sciences.
The ability to collate, interpret and explain the significance and underlying theory of experimental data, including an assessment of limits of accuracy.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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.
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 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.
Generic skills needed for students to undertake further training of a professional nature.

Method of Assessment

Inorganic Chemistry Assignment (~2 hours) – 7.5%
Fibres & Microscopy Assignment (~2 hours) – 7.5%
Practical Laboratory Reports (each taking ~3 hours) – 25%
Examination (3 hours) – 60%

Preliminary Reading

Cotton, Wilkinson and Gaus, Basic Inorganic Chemistry. (3rd edition, 1995, Wiley)
Greenwood and Earnshaw, Chemistry of the Elements. (2nd revised edition, 1997, Butterworth-Heinemann Ltd)
Winter, d-Block Chemistry, (1994, Royal Society of Chemistry)
Jones, d- and f-Block Chemistry, (2001, Royal Society of Chemistry)
Bell, Forensic Chemistry, (2nd edition, 2012, Prentice Hall)

Pre-requisites

Prerequisite:
CHEM308 Molecules Matter and Energy
PS381

Synopsis *

Inorganic Chemistry:
Here, you will explore the chemistry of the d- and f-block elements, including their electronic and colour properties as well as their magnetic behaviour, both in lectures and workshops and also practically through a lab component. Fibres and Microscopy: What is a fibre and associated polymers and how are they made? Cellulose and other natural polymers. Synthetic polymers and fibres such as nylon. Overview of methods of identification and analysis. A particular emphasis will be on polarized light microscopy for comparative analysis various materials including fibres, paper and soils.

Laboratory:
Experiments in preparative and analytical inorganic chemistry, to include: the separation of nickel and cobalt by ion-exchange chromatography; measurement of the ligand field splitting energy in a titanium (III) complex; preparation and properties of complex ions; isomerism in coordination complexes.

PS556 Firearms & Ballistics

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 51
Private study hours: 99
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
The internal working of a range of firearms.
Heat transfer within firearms.
How firearms can fail and why.
How sound and flash moderators operate.
In depth analyses of cartridge cases and bullets.
The different methods utilised for gunshot residue analyses.
Methods employed for serial number restoration of tampered with firearms.
The reconstruction of bullet trajectories from crime scene evidence.
Extrapolation of useful information from ballistic trauma.
The consideration of all evidence at a shooting scene to reconstruct possible scenarios.
The effect of fragments from Improvised Explosive Devices (IEDs) on the body and structures.
A consideration of how to take a multidisciplinary approach to ballistics.
Up-to-date research in the field of ballistics.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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

Assignment 1 (8%) - 3 hours
Assignment 2 (16%) - 1000 words
Assignment 3 (16%) - 1000 words
Examination (60%) - 2 hours

Preliminary Reading

Criminalistics (An introduction to Forensic Science), Richard Saferstein (2015), Prentice Hall. ISBN 0-13-013827-4
Understanding Firearm Ballistics, R.A. Rinker (2005). Mullberry Hs, USAISBN 0-9645598-4-6
Practical Skills in Forensic Science (2005), Pearson Press ISBN 0-131-14400-6
Wounds Ballistics and the Scientific Background (2011), Karl G. Sellier, Beat P. Kneubuehl, ISBN 0444815112
Wound Ballistics: Basics and Applications: Robin M Coupland, Beat P. Kneubuehl, Markus A Rothschild, Michael J Thali (2011), ISBN 3642203558

Pre-requisites

Prerequisite:
PSCI3240 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	

Availability

This is not available as a wild module.

Contact Hours

Students will spend between 9-12 months working at the organisation hosting their placement
Total study hours: 900

Learning Outcomes

The 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.

The 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

Assignment – Pass/Fail
Assignment – Pass/Fail

Preliminary Reading

None

Pre-requisites

Co-requisite:
PSCI5920 Industrial Placement Assessment

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	

Availability

This is not available as a wild module.

Contact Hours

Students will spend between 9-12 months working at the organisation hosting their placement
Total study hours: 300

Learning Outcomes

The 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.

The 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

Assignment (approx 30 pages, 70%)
Presentation (20 mins, 30%)

Preliminary Reading

None

Pre-requisites

Co-requisite:
PSCI5910 Industrial Placement Experience

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have:
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.
Skills in essay writing and presenting scientific material and arguments clearly and correctly, in writing and orally, to a range of audiences including legal contexts.
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.

Method of Assessment

Assignment 1 (4 hours, 10%)
Assignment 2 (4 hours, 10%)
Examination (3 hours, 80%)

Preliminary Reading

Crime Scene to Court, the Essentials of Forensic Science, 4th edition, ed. P. White. Royal Society of Chemistry, 2016.
Criminalistics, 10th edition, R. Saferstein. Prentice Hall, 2010.
Forensic Science, 4th edition, A.R.W. Jackson & J. M. Jackson. Pearson, 2016.
The Chemistry of Explosives, J. Akhavan. Royal Society of Chemistry. 3rd edition, 2011
Kirk's Fire Investigation, J. DeHaan. Prentice Hall. 7th edition, 2011

Pre-requisites

Pre-requisite:
Successful completion of Stage 2 in the Forensic Science or Chemistry and related degree programmes, or equivalent at another University.

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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 14
Private study hours: 136
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Forensic Science.
Present scientific material and arguments clearly and correctly, in writing and orally, to a range of audiences.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate communication skills, covering both written and oral communication.
Use time-management and organisational skills, as evidenced by the ability to plan and implement efficient and effective modes of working.

Method of Assessment

Writing an Expert Witness Report (3 pages) – 40%
Poster – 20%
Defending an Expert Witness Report (3 pages) – 40%

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, (2017) Forensic Science, Pearson, Prentice Hall

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.
Designing and producing a poster.
Acting as an expert forensic science witness. Writing and defending an expert witness report.

PS605 Study and Employability Skills for Level 6

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
1	Canterbury	Whole Year	H	1 (0.5)	Pass/Fail Only	

Contact Hours

Total Contact Hours: 5
Private Study Hours: 5
Total Study Hours: 10

Learning Outcomes

1 Communication and presentation
2 Data analysis
3 Research
4 Self-directed learning
5 Career planning

Method of Assessment

Formative assessment/feedback only.

Preliminary Reading

No formal reading list. Students may be directed to reading materials for specific tutorials

Restrictions

Not available as an elective module.

Synopsis *

One-on-one meetings and group tutorials focused on academic progression and the development of key skills to support the core curriculum and future study or employment. Students meet with their Academic Advisor individually or in groups at intervals during the academic year. Individual meetings review academic progress, support career planning etc. Themed tutorials develop transferable skills; The tutorials are informal involving student activity and discussion. Year group events deliver general information e.g. on University resources, 4-year programmes, module selection etc.

PS620 Forensic Science Project

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 135 hours
Private study hours: 165 hours
Total study hours: 300 hours

Learning Outcomes

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

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

Supervisor Mark (20%) - length N/A
Progress Report (10%) - 2 pages of A4
Presentation (20%) - 10 minutes
Dissertation (50%) - 6,000-10,000 words

Preliminary Reading

Practical Skills in Forensic Sciences, Langford et al, Prentice Hall, 2005
Your student research project, Martin Luck, Gower, 1999

Specialists texts and journals as appropriate to the project topic.

Pre-requisites

None

Synopsis *

Development of a project topic and carrying out independent research.
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	
1	Canterbury	Whole Year	H	15 (7.5)	80% Exam, 20% Coursework with Compulsory Numeric Elements	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

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

Demonstrate knowledge and understanding of core biological concepts, terminology, theory, units, conventions, and methods, including knowledge of cells, biochemistry and human DNA.
Demonstrate 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.
Use skills required for, and knowledge of, the analysis of forensic DNA.
Interpret data derived from laboratory observations and measurements in terms of their underlying significance and the theory underpinning them.
Display 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.

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

Recognise and implement good measurement science and practice.
Solve problems, relating to qualitative and quantitative information, extending to situations where evaluations have to be made on the basis of limited information.
Use information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.

Method of Assessment

Genotyping exercise (two pages, 10%)
Lab write up (six pages, 10%)
Examination (three hours, 80%)
The genotyping exercise and the lab write up are compulsory sub-elements and must be passed to pass the module

Preliminary Reading

Publications from the learned literature including journal articles from Science & Justice and Forensic Science International
Fundamentals of Forensic DNA typing (Butler 2009, Academic Press)
Forensic DNA typing (Butler 2005, Academic Press)

Pre-requisites

Prerequisite:
CHEM3140 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	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours 35
Private study time 115
Total study hours 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Demonstrate an ability to identify relevant principles and laws when dealing with problems, and to make approximations necessary to obtain solutions.
Demonstrate 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.
Demonstrate competent use of appropriate C&IT packages/systems for the analysis of data and the retrieval of appropriate information.
Demonstrate an ability to present and interpret information graphically.
Demonstrate an ability to communicate scientific information, in particular to produce clear and accurate scientific reports.
Demonstrate an ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
MPhys/MSci/MSc students:- Demonstrate an ability to communicate complex scientific ideas, the conclusion of an experiment, investigation or project concisely, accurately and informatively.
MPhys/MSci/MSc students:- Demonstrate an ability to make use of research articles and other primary sources.

The intended generic learning outcomes. On successfully completing the module students will be able to:
Demonstrate 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.
Demonstrate 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.
Demonstrate 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.
Demonstrate personal skills – the ability to work independently and as part of a group, to use initiative, to organise oneself to meet deadlines and to interact constructively with other people.
Demonstrate self-direction and originality in applying and adapting problem-solving skills to unfamiliar, complex and open-ended situations.
Demonstrate the independent learning ability required for continuing professional development.
Establish advanced research skills needed at a postgraduate level or graduate level in other sectors.
Demonstrate the capacity to undertake advanced scientific investigations, advanced problem solving and data analysis in a research environment.

Method of Assessment

100% coursework. The coursework assesses student's familiarity with and ability to implement current research methods. Preparation of their coursework will require independent, original problem solving while planning carefully for the time available and to present their work in a professional manner.

Colloquium Report 1 (10 hours) 20%
Colloquium Report 2 (10 hours) 20%
Application outline (4 hours) 10%
Group Research Project (30 hours) 40%
Poster Presentation of Project (10 hours) 10%

Preliminary Reading

http://www.epsrc.ac.uk/
http://www.scitech.ac.uk

On writing proposals:
https://www.epsrc.ac.uk/funding/howtoapply/preparing

FOR WRITING A FUNDING PROPOSAL
http://www.learnerassociates.net/proposal/
http://www.learnerassociates.net/proposal/

Pre-requisites

None.

Synopsis *

Students will develop a number of skills related to the investigation and planning of research such as analytical skills, critical thinking and ability to understand and communicate scientific information in graphically. Students will learn how to search and retrieve information from a variety of locations (colloquia, websites, journals, proceedings etc). They will learn how to compile professionally-produced scientific documents such as colloquia reports, posters and applications for funding of future research activities/research job applications. The Group research investigation strengthens these skills, adding experience of working in a team.

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

Total contact hours: 31
Private study hours: 119
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have:
A systematic understanding and a critical awareness of some current topics of interest in materials research.
A understanding of techniques applicable for synthesis and purification of materials.
A 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

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

Assignment 1 (3-4 pages, 6.67%)
Assignment 2 (3-4 pages, 6.67%)
Assignment 3 (3-4 pages, 6.67%)
Examination, 3 hours (80%)

Preliminary Reading

- Dieter Vollath "Nanomaterials", Wiley, 2013
- Anthony R. West “Solid State Chemistry and Its Applications”, Wiley, 2014
- Richard J. D. Tilley “Defects in Solids”, Wiley, 2008
- Richard M. Martin “Electronic Structure”, Cambridge University Press, 2008

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 photovoltaics), for the optics and electronics industry (glasses and semiconductors). The aim of this module is to introduce students to this area of modern materials and associated techniques. Examples of the topics that might typically be covered are: Crystal growth and defects; Liquid crystals; Nanomaterials; Glases; Magnetism and Magnetic Materials; Multiferroics; X-ray absorption spectroscopy (XAS).

PS712 Advanced Topics in Forensic Science

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

Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a detailed comprehension of the role of evaluative and interpretive opinion in forensic science.
Appreciate the value of the statistical approach to the testimony whilst understanding the strengths and weaknesses of the qualitative and quantitative approaches to expressing opinion.
Understand the importance of key cases in shaping the weight of opinion and how cases are evaluated in modern-day forensic testimony.
Understand the role of quality in forensic science. They will distinguish the different quality standards associated with the forensic process, as well as recognise the value of competency testing, proficiency trials and continuing professional development.
Gain knowledge of the codes of ethical conduct applicable to forensic scientists and identify ethical challenges using a review of contemporary cases.
Be able to critically analyse a range of contemporary and advanced topics associated with forensic science.

The intended generic learning outcomes.On successfully completing the module students will be able to:
Have:
Communication skills, covering both written and oral communication.
Information-retrieval skills, in relation to primary and secondary information sources, including information retrieval through on-line computer searches.

Method of Assessment

Assignment (20%) – 2,000 word essay
Examination (80%) - 3 hours

Preliminary Reading

Publications from the learned literature including journal articles from Science & Justice and Forensic Science International.
Forensic Science (Jackson and Jackson) ISBN 978-013-199880-3
Ethics in Forensic Science (Swienton et al) ISBN 0123850193
Ethics and the Practice of Forensic Science (Bowen) ISBN 978-14-20088-939
Misleading DNA Evidence (Peter Gill) ISBN 9780124172142
Forensic Science and the Law (Anna Sandlford) ISBN 9780864728418

Pre-requisites

Prerequisite:
Successful completion of Stage 2 Forensic Science degree or equivalent.

Synopsis *

This module will include the principles of application, quality and legal aspects of analysis and identification using several evidence types – entwined with case examples of major crimes. The module is intended to cover the most up to date topics within forensic science and will be supported with a wide range of contemporary case studies.

The module will include the following subject areas:
Case Assessment & Interpretation.
A selection of contemporary case studies demonstrating the application of forensic science.
Quality standards in forensic science.
Ethics in forensic science.
Bias

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	

Availability
This is not available as a wild module.

Contact Hours
Total contact hours: 30
Private study hours: 120
Total study hours: 150

Learning Outcomes
The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
The theoretical chemistry of the principles of analysis and identification of several chemicals that are related to substances of abuse.

The intended generic learning outcomes. On successfully completing the module students will be able to:
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
Scientific Presentation (15 mins plus questions, 15%)
Case Study Presentation (5-7 mins, 10%)
Assignment (5%)
Examination (3 hours, 70%)

Preliminary Reading
Clarke's Analytical Forensic Toxicology, Pharmaceutical Press; 1st edition (30 Jun 2008) ISBN-10: 0853697051; ISBN-13: 978-0853697053
Michael D. Cole, The Analysis of Controlled Substances: A Systematic Approach. Cole 2003. 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
Prerequisite:
CHEM3140 Introduction to Biochemistry and Drug Chemistry

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:

Amphetamines and related compounds
LSD and related compounds
Cannabis and Cannabis products
Opiate compounds
Cocaine and related compounds
Certain controlled pharmaceutical drugs

PS717 Modern Approaches to Incident Management

Version	Campus	Term(s)	Level	Credit (ECTS)	Assessment	Convenor
3	Canterbury	Whole Year	M	30 (15)	100% Coursework	

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 55
Private study hours: 245
Total study hours: 300

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Understand the general processes involved with managing various incident types (indicative topics may include – civil infrastructure incidents, disaster victim identification (DVI), acts of terrorism and weapons of mass destruction (WMDs) and smaller scale murder scene investigation).
Understand evidential prioritisation in relation to incident investigation.
Manage evidence recovery, storage and analysis.
Manage personnel & logistics in live and simulated incidents.
Write a critical report based on their own incident scene management.
Understand the science underlying chemical, biological, radiological and nuclear (CBRN) incidents.
Use computer simulations to aid their understanding of incident investigation and interpretation.
Apply a multidisciplinary scientific knowledge to their incident investigation processes across many different possible scenarios (see the first learning outcome above for indicative topics).

The intended generic learning outcomes. On successfully completing the module students will be able to:
Manage time, resources, and personnel.
Solve problems during real-time incidents and simulated exercises.
Communicate clearly with a variety of personnel.
Write reports to a professional level.
Use computer software effectively to model various complex scenarios.

Method of Assessment

Incident Management Practical – 3 hours (25%)
Incident Report – 3000 words (15%)
Table-top incident simulation – 3 hours (25%)
Incident Portfolio – 5,000 words (35%)

Preliminary Reading

Core text:
Introduction to Emergency Management, Haddow. 2008.

Recommended reading:
Aircraft Safety, Kraues. 2003
Maritime Safety: The Human Factors. Trafford. 2009. Book Guild Publishing
Homeland Security in the UK: Future Preparedness for Terrorist Attack since 9/11: Wilkinson.2007
Blackstone's Counter-Terrorism Handbook: Stainforth. 2010 OUP
Derail: Why Trains Crash. Faith: 2000. Channel 4 Publishing
Air Accident Investigation. Owen. 2001.
The Terrorism Reader: 4th Edition. Whittaker. 2012.
Explaining terrorism; causes, processes and consequences. Crenshaw,
Techniques of crime scene investigation, CRC Press, Fisher, 2012,

Pre-requisites

None.

Synopsis *

This module will cover the core principles behind the management and investigation processes that may relate to a range of forensically-relevant incident types. Indicative areas of discussion may include investigation of civil infrastructure incidents, disaster victim identification (DVI), acts of terrorism and weapons of mass destruction (WMDs) as well as managing forensic resources over a range of major and smaller incidents.

In addition to the process-driven content above, students will further study the relevant science behind some of the incident types and develop the capability to computer model various aspects of these events. This ultimately provides students with the ability to take a modern, holistic and multidisciplinary scientific approach when interpreting what may have happened during such events.

PS720 Advanced Project Laboratory

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 84
Private study hours: 216
Total study hours: 300

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Have:
Knowledge and understanding of core scientific physical, biological, and chemical concepts, terminology, theory, units, conventions and laboratory methods in relation to forensic science and/or chemistry
Knowledge and understanding of advanced theory, concepts, and practice in chemical identification techniques
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 problems at an advanced level
Ability to recognise and implement good measurement science and practice and commonly used forensic/chemical 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 chemical identification 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

The intended generic learning outcomes. On successfully completing the module students will be able to:
Have a knowledge and understanding of:
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/chemistry practice and research

Method of Assessment

Experiment 1 (1000 word equivalent, 7.5%)
Experiment 2 (1000 word equivalent, 7.5%)
Experiment 3 (1000 word equivalent, 7.5%)
Experiment 4 (1000 word equivalent, 7.5%)
Experiment 5 (1000 word equivalent, 7.5%)
Experiment 6 (1000 word equivalent, 7.5%)
Detailed Literature Review Outline – 1000 words (15%)
Presentation – 15 minutes (15%)
Literature Review Dissertation – 5000 words (25%)

Preliminary Reading

Chemistry3, Burrows, Holma, Parsons, Pilling, Price, Oxford University Press, 2009, ISBN978-0-19-969185-2
Practical Skills in Forensic Science. Langford et al, Prentice Hall, 2010, ISBN13: 9780132391436
Practical Skills in Chemistry, Dean et al, Prentice Hall, 2011, ISBN13: 9780273731184
Lab Manual for Criminalistics: an introduction to forensic science. Saferstein et al., Pearson, 2011, ISBN13: 9780135099445

Specialist texts and journal articles as appropriate to each experimental method.
Specialist texts and journal articles as appropriate to the project topic; these are necessarily bespoke the project itself.

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 (PSCI7400 and CHEM7400) 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.

PS740 Forensic Science Research Project MSCI

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

Availability

This is not available as a wild module.

Contact Hours

Total contact hours: 348
Private study hours: 252
Total study hours: 600

Learning Outcomes

The intended subject specific learning outcomes. On successfully completing the module students will be able to:
Build on the research independence gained in year 3 as part of PSCI7200 (Advanced Forensic Science Laboratory).
Establish advanced research skills at Level 7.
Have the capacity to undertake advanced scientific investigations, advanced problem solving and data analysis in a research environment.
Have the ability to communicate scientific ideas through presentations and written reports.
In conjunction with PSCI7000 (Physical Science Research Planning) to gain knowledge of how research is structured and funded.
Have time management and forward planning skills.

The intended generic learning outcomes. On successfully completing the module students will be able to:
It is considered that the subject specific learning outcomes and assessment pattern fulfil or contribute to the following learning outcomes;

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 novel problems and plan strategies for their solution by the evaluation, interpretation and synthesis of scientific information and data by a variety of computational methods.
Ability to recognise and implement good measurement science and practice and commonly used Forensic/Chemistry laboratory techniques. Including the ability to select the most appropriate techniques for a given analysis and to use a wide range of advanced apparatus. Ability to exercise Good Laboratory Practice (GLP) including 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 and the skills required to conduct of standard laboratory procedures (including the operation of standard forensic instrumentation such as that used for analytical investigations and separation).
Skills in essay writing and presenting scientific material and arguments clearly and correctly, in writing and orally, to a range of audiences. The ability to communicate complex scientific arguments to a lay audience.
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 to an examining body for example as an expert witness.
Communication skills, covering both written and oral communication. Self management and organisational skills with the capacity to support life-long learning. Including Information technology skills such as word processing and spreadsheet use, data logging and storage, internet communications etc.
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.
Time management and organisational skills as evidenced by the ability to plan and implement efficient and effective modes of working. Including the study skills necessary for continuing professional development and preparation for employment as a practicing forensic scientist or chemist.

Method of Assessment

Progress report (approx 4 pages, 10%)
Final report (approx 20-50 pages depending on project, diagrams etc. 50%)
Supervisor mark (20%)
Presentation (20 mins, 20%)

Preliminary Reading

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

Pre-requisites

Prerequisite:PSCI7200
Co-requisite: PSCI7000

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.