Physics

The undergraduate subjects in the School of Physics form a study of the universe at its most profound level. These subjects provide students with the opportunity to gain a deeper understanding of the foundations and methodology of physics through both theoretical and experimental studies.

Students completing studies in physics will be able to:

- explain fundamental phenomena in a wide range of areas including classical and quantum mechanics, thermal and statistical physics, astronomy and astrophysics, optics, nuclear and particle physics and electronics;
- apply these principles to situations in the physical and biological sciences and engineering;
- solve problems using mathematical and computational methods and analyse and interpret the results;
- demonstrate an understanding of a wide variety of advanced experimental techniques;
- acquire and interpret experimental data;
- write and evaluate scientific and technical reports; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Subject choices

Standard and advanced levels

Many physics subjects are offered at standard and advanced levels. The treatment of the subject matter in the advanced subjects will be deeper and may involve more sophisticated mathematics.

Admission to advanced level subjects at 100-level is restricted to students with a strong background in physics and mathematics and preference may be given to students intending to specialise in physics. Admission to advanced level subjects in 200- and 300-level is restricted to students who continue to obtain good marks in the prerequisite subjects and in physics and mathematics as a whole (the usual requirement being an average of 70% or more in the principal physics and mathematics subjects of the previous level).

Students with adequate preparation do not disadvantage themselves by taking advanced level subjects.

100-level subjects

Coordinator: Dr M K Livett (Director of First Year Studies)

Four 100-level physics subject streams are offered by the School of Physics, each made up of two one-semester subjects normally taken together. A two-semester subject sequence in astronomy is also offered.

- 640-121 plus 640-122 Physics (Advanced) is an intellectually rigorous stream suited to students, embarking on any career, who have a strong background in physics and mathematics. The sequence assumes a high level of achievement in VCE Unit 3/4 Physics and Specialist Mathematics. Students who are adequately prepared will not be disadvantaged in their marks by choosing the advanced subjects.
- 640-141 plus 640-142 Physics provide a broad coverage of physics principles and applications suited to students wishing to specialise in any physical, technological or biological discipline. The sequence assumes knowledge of VCE Unit 3/4 Physics and Mathematics, including calculus.
- 640-161 plus 640-162 Physics: Principles and Applications provide a well-rounded, more descriptive treatment of physics for students who do not have a solid background in physics and mathematics. The subjects assume some prior knowledge of physics and mathematics but not to VCE Unit 3/4 level. Students who have completed VCE Unit 3/4 Physics or equivalent will not normally be permitted to enrol in these subjects. Students with strong results in 640-161 plus 640-162, together with appropriate mathematics, may be permitted to proceed to later year physics subjects.
- 640-151 plus 640-152 Physics for Biomedical Science is a core subject sequence in the Bachelor of Biomedical Science course. It assumes some knowledge of physics and VCE Unit 3/4 Mathematical Methods. For BSc students, entry to these subjects is by invitation from the head of the School of Physics, usually requiring a very high level of achievement in the final year of secondary school.
- 640-176 The Solar System and the Cosmos and 640-177 Stars and Galaxies are optional astronomy subjects. 640-177 assumes familiarity with basic physical concepts.

Students who have concerns about their preparation in mathematics and physics are recommended to revise their knowledge by preliminary reading of an appropriate text, eg. R Cole, *So You Want to Take Physics? A Preparatory Course with Calculus*, Saunders, 1993, (for 640-121 plus 640-122 and 640-141 plus 640-142 and 640-151 plus 640-152) or R Cole, *So You Want to Take Physics? A Preparatory Course*, Saunders, 1993, (for 640-161 plus 640-162).

200-level subjects

Coordinator: Dr A Melatos

Students planning to specialise in physics must include in their courses physics 640-223 or 640-243; 640-225 or 640-245; and 640-299; and mathematics 620-231 (or 620-233) and 620-232 (or 620-234). These mathematics subjects are prerequisites for some 200-level and 300-level physics subjects.

300-level subjects

Coordinator: Dr A Melatos

300-level subjects fall into three groups: core subjects, options and laboratory subjects. The core subjects are 640-321 or 640-341, 640-322 or 640-342, 640-323 or 640-343, and 640-353. The laboratory subjects are 640-393 and 640-394.

With the exception of 640-353, the core subjects are run at both standard and advanced levels. The subject pairs (640-321 and 640-341), (640-322 and 640-342) and (640-323 and 640-343) cover similar material though to different levels of depth. The core subjects cover those key aspects of theoretical physics required for all students specialising in physics, while the options provide students with the opportunity to increase both the breadth and depth of their knowledge of physics.

The standard laboratory sequence taken by most students specialising in physics and wishing to proceed to honours-level studies in physics totals 25 points. This is usually achieved by completing 640-393 and 640-394.

Students who are considering honours-level studies in physics should construct their 300-level courses with a view to meeting the prerequisites described in the Bachelor of Science (Honours) section of this Handbook.

Note that the book S B Palmer and M S Rogalski, *Advanced University Physics*, Gordon and Breach, 1996, may be a useful adjunct to the prescribed texts for the various 300-level units. This book summarises a range of theoretical physics material including classical mechanics, optics, electrodynamics, quantum mechanics, solid state physics and nuclear physics.

Note also that all students specialising in physics must enrol in 640-310 Physics Undergraduate Seminar.

Suggested courses of study

100-level subjects

Physics 640-121 plus 640-122 or 640-141 plus 640-142, mathematics 620-121, 620-122, and 620-123 or 620-141, 620-142, and 620-143, with either Scientific Programming and Simulation 620-131 or Experimental Design and Data Analysis 620-160 and one of chemistry 610-121 plus 610-122, or 610-141 plus 610-142, Earth sciences 625-101 and 625-102, biology 600-141 plus 600-142 or computer science 433-141 and 433-142.

200-level subjects (physics/mathematics students)

Physics:

- Quantum Mechanics and Thermal Physics 640-223 or 640-243,
- Electromagnetism and Relativity 640-225 or 640-245,
- Instrumentation for Scientists 640-251,
- Laboratory Work 640-299; and

Mathematics:

- Vector Analysis 620-231 or 620-233,
- Mathematical Methods 620-232 or 620-234,

Plus two or more subjects selected from:

- Further Classical and Quantum Mechanics 640-234,
- Astrophysics and Optics II 640-237,
- Real and Complex Analysis 620-221,
- Analysis 620-252,
- Linear and Abstract Algebra 620-222.

200-level subjects (physics/chemistry students)

Physics:

- Quantum Mechanics and Thermal Physics 640-223 or 640-243,
- Further Classical and Quantum Mechanics 640-234 (optional),
- Laboratory Work 640-299; and

Mathematics:

- Vector Analysis 620-231 or 620-233,
- Mathematical Methods 620-232 or 620-234

Chemistry:

- Light, Matter and Chemical Change A 610-210,
- Analysis in Chemical and Life Sciences 610-260,
- Organic Chemistry 610-220,

- Inorganic and Bio-inorganic Chemistry 610-240.

Please note that this combination of subjects may lead to a major in physics but would not permit entry to physics honours. It may also lead to a major in chemistry.

300-level subjects

- Quantum Mechanics 640-321 or 341;
- Thermal Physics 640-322 or 640-342;
- Electrodynamics 640-323 or 640-343;
- Atomic, Molecular and Solid State Physics 640-353; and
- Laboratory Work 640-393 and 640-394 or mathematics subjects required as an alternative for entry to physics honours. Please refer to *Bachelor of Science (Honours) and Bachelor of Information Systems (Honours) (p.1)*.
- Additional subjects selected from 300-level physics or elsewhere.

Note that many combinations of subjects may be selected to satisfy the minimum requirement for a major in physics.

Bachelor of Science (Honours)

For information about faculty and departmental entry requirements for Honours, please refer to *Bachelor of Science (Honours) and Bachelor of Information Systems (Honours) (p.1)*. These requirements should be considered when planning your course.

Further information

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Subject descriptions

100-level subjects

640-121 Physics A (Adv)

Note: Students may only gain credit for one of 640-005, 640-121, 640-141, 640-151 and 640-161.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M K Livett

Prerequisites: A high level of achievement in VCE Unit 3/4 of Physics and Specialist Mathematics, or equivalent.

Contact: Thirty-six lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 1)*.

Description: This subject is designed for students with a strong background in physics. It aims to provide students with a deep understanding of a broad range of physics principles together with the application of these principles to physical and biological situations.

Students completing this subject will be able to:

- explain the basic principles of translational and rotational mechanics, waves and thermal physics;
- apply these principles, together with mathematical reasoning, to situations in the physical and biological sciences; and
- acquire and interpret experimental data.

In addition students will be able to:

- participate as an effective member of tutorial, laboratory and study groups;
- communicate their understanding of physics orally and in written form in tutorials, lab classes and study groups; and
- manage their time commitments to this subject in order to be prepared for regular lab and tutorial classes as well as tests and examination.

The subject provides an introduction to mechanics: kinematics and dynamics of particles and rigid bodies, gravitation, physical introduction to special relativity; mechanical properties of matter: fluid statics and dynamics, elasticity; mechanical waves: propagation, dynamics, superposition; thermal physics: thermal properties of matter, thermodynamics, kinetic theory of gases, heat transfer.

Assessment: A 3-hour end-of semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent of 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: D Halliday, R Resnick and J Walker, *Fundamentals of Physics*, 6th edn, Wiley 2001.

640-122 Physics B (Adv)

Note: Students may only gain credit for one of 640-006, 640-122, 640-142, 640-152 and 640-162.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M K Livett

Prerequisites: A high level of achievement in VCE Unit 3/4 Physics and Specialist Mathematics or equivalent. It will be assumed that students are familiar with the content of 640-121 Physics A (Adv) *(p.2)*.

Contact: Thirty-six lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 2)*.

Description: This subject is designed for students with a strong background in physics. It aims to provide students with a deep understanding of a broad range of physics principles together with the application of these principles to physical and biological situations.

Students completing this subject will be able to:

- explain the basic principles of electricity and magnetism, wave and particle nature of light, atomic and nuclear physics;
- apply these principles, together with mathematical reasoning, to situations in the physical and biological sciences; and
- acquire and interpret experimental data.

In addition students will be able to:

- participate as an effective member of tutorial, laboratory and study groups;
- communicate their understanding of physics orally and in written form in tutorials, lab classes and study groups; and
- manage their time commitments to this subject in order to be prepared for regular lab and tutorial classes as well as tests and examination.

The subject provides an introduction to electromagnetism: electrostatics, circuits, magnetism, electric and magnetic properties of matter, Maxwell's equations, electromagnetic waves; quantum theory: historical foundation, wave and particle properties of electrons and photons, and atomic and nuclear physics: atomic and nuclear structure, X-rays, radioactivity, and nuclear radiations, fission and fusion, nuclear power.

Assessment: A 3-hour end-of-semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: D Halliday, R Resnick and J Walker, *Fundamentals of Physics*, 6th edn, Wiley 2001.

640-141 Physics A

Note:

- Students may only gain credit for one of 640-005, 640-121, 640-141, 640-151 and 640-161.
- Students who have not completed the equivalent of VCE Specialist Mathematics Units 3 and 4 are encouraged to enrol in a Semester 1 mathematics subject concurrently with this subject.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M K Livett

Prerequisites: VCE Unit 3/4 Physics and Mathematical Methods or equivalent. VCE Unit 3/4 Specialist Mathematics or equivalent is recommended but not required.

Contact: Thirty-six lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 1)*.

Description: This subject is designed for students with a sound background in physics. It aims to provide students with an understanding of a broad range of physics principles together with the application of these principles to physical and biological situations.

Students completing this subject will be able to:

- explain the basic principles of translational and rotational mechanics, waves and thermal physics;
- apply these principles, together with mathematical reasoning, to situations in the physical and biological sciences; and
- acquire and interpret experimental data.

In addition students will be able to:

- participate as an effective member of tutorial, laboratory and study groups;
- communicate their understanding of physics orally and in written form in tutorials, lab classes and study groups; and
- manage their time commitments to this subject in order to be prepared for regular lab and tutorial classes as well as tests and examination.

The subject provides an introduction to: mechanics: kinematics and dynamics of particles and rigid bodies, gravitation, physical introduction to special rela-

tivity; mechanical properties of matter: fluid statics and dynamics, elasticity; mechanical waves: propagation, dynamics, superposition; thermal physics: thermal properties of matter, thermodynamics, kinetic theory of gases, heat transfer.

Assessment: A 3-hour end-of semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent of 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: D Halliday, R Resnick and J Walker, *Fundamentals of Physics*, 6th extended edn, Wiley, 2001.

640-142 Physics B

Note:

- Students may only gain credit for one of 640-006, 640-122, 640-142, 640-152 and 640-162.
- Students who have not completed the equivalent of VCE Specialist Mathematics Units 3 and 4 are encouraged to enrol in a Semester 1 mathematics subject to prepare for this subject.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M K Livett

Prerequisites: VCE Unit 3/4 Physics and Mathematical Methods or equivalent. VCE Unit 3/4 Specialist Mathematics or equivalent is recommended but not required. It will be assumed that students are familiar with the content of 640-141 Physics A *(p.2)*.

Contact: Thirty-six lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 2)*.

Description: This subject is designed for students with a sound background in physics. It aims to provide students with a deep understanding of a broad range of physics principles together with the application of these principles to physical and biological situations.

Students completing this subject will be able to

- explain the basic principles of electricity and magnetism, wave and particle nature of light, atomic and nuclear physics;
- apply these principles, together with mathematical reasoning, to situations in the physical and biological sciences; and
- acquire and interpret experimental data.

In addition students will be able to:

- participate as an effective member of tutorial, laboratory and study groups;
- communicate their understanding of physics orally and in written form in tutorials, lab classes and study groups; and
- manage their time commitments to this subject in order to be prepared for regular lab and tutorial classes as well as tests and examination.

The subject provides an introduction to electromagnetism: electrostatics, circuits, magnetism, electric and magnetic properties of matter, Maxwell's equations, electromagnetic waves; quantum theory: historical foundations, wave and particle properties of electrons and photons; and atomic and nuclear physics: atomic and nuclear structure, X-rays, radioactivity, and nuclear radiations, fission and fusion, nuclear power.

Assessment: A 3-hour end-of-semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: D Halliday, R Resnick and J Walker, *Fundamentals of Physics*, 6th edn, Wiley, 2001.

640-161 Physics: Principles & Applications A

Note:

- Students may only gain credit for one of 640-005, 640-121, 640-141, 640-151 and 640-161.
- Students who have completed VCE Unit 3/4 Physics or equivalent will not normally be permitted to enrol in this subject.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M K Livett

Prerequisites: Some knowledge of physics and at least one secondary school final-year mathematics subject.

Contact: Thirty-six lectures (three per week), 12 one-hour tutorials and 30 hours practical work (three hours per week) *(Semester 1)*.

Description: This subject is designed for students with a minimal background in physics. It aims to provide them with an understanding of a broad range of elementary physics principles together with applications of these principles to physical and biological situations. Simple mathematics is used throughout.

Students completing this subject will be able to:

- explain the basic principles of translational and rotational mechanics, waves and thermal physics;
- apply these principles, together with mathematical reasoning, to situations in the physical and biological sciences; and
- acquire and interpret experimental data.

In addition students will be able to:

- participate as an effective member of tutorial, laboratory and study groups;
- communicate their understanding of physics orally and in written form; and
- manage their time commitments to this subject in order to be prepared for regular lab and tutorial classes as well as tests and examination.

The subject provides an introduction to the following areas: translational and rotational motion: the motion of particles and rigid bodies, gravitation; properties of stationary and moving fluids; elastic properties of materials; motion and superposition of waves, including sound; and thermal properties of matter at both macroscopic and microscopic levels, energy transfer by heating.

Assessment: A 3-hour end-of-semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent of 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: D C Giancoli, *Physics Principles with Applications*, 5th edn, Prentice-Hall, 1998.

640-162 Physics: Principles & Applications B

Note:

- Students may only gain credit for one of 640-006, 640-122, 640-142, 640-152 and 640-162.
- Students who have completed VCE Unit 3/4 Physics or equivalent will not normally be permitted to enrol in this subject. Such students should enrol in 640-142 or 640-122.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M K Livett

Prerequisites: Some knowledge of physics and at least one secondary school final-year mathematics subject. It will be assumed that students are familiar with the content of 640-161 Physics: Principles & Applications A *(p.3)*.

Contact: Thirty-six lectures (three per week), 12 one-hour tutorials and 30 hours practical work (three hours per week) *(Semester 2)*.

Description: This subject is designed for students with a minimal background in physics. It aims to provide them with an understanding of a broad range of elementary physics principles together with applications of these principles to physical and biological situations. Simple mathematics is used throughout.

Students completing this subject will be able to:

- explain the basic principles of electricity and magnetism, wave and particle nature of light, atomic and nuclear physics;
- apply these principles, together with mathematical reasoning, to situations in the physical and biological sciences; and
- acquire and interpret experimental data.

In addition students will be able to:

- participate as an effective member of tutorial, laboratory and study groups;
- communicate their understanding of physics orally and in written form; and
- manage their time commitments to this subject in order to be prepared for regular lab and tutorial classes as well as tests and examination.

The subject focuses on the following areas: forces between charged particles as seen in electrostatics and electric circuits; magnetic properties of matter, magnetic forces and electromagnetic induction; behaviour of light: optical instruments, interference, diffraction, dispersion and polarisation; wave and particle behaviours of electrons and photons; structure of the atom and nucleus; and nuclear radiation.

Assessment: A 3-hour end-of-semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent of 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: D C Giancoli, *Physics Principles with Applications*, 5th edn, Prentice-Hall, 1998.

640-176 The Solar System and the Cosmos

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr R Webster

Contact: Thirty-six lectures (three per week); 30 hours practical work (three hours per week) *(Semester 1)*.

Description: Astronomy is one of the most rapidly changing branches of science. The latest results from the Hubble space telescope and other telescopes will be given. How they affect our understanding in a range of fascinating topics, such as black holes, other planets, comets and extraterrestrial life, will be

discussed. Scientific methods used to investigate the solar system and the cosmos will be explained. Basic physical concepts required to understand the formation and evolution of our solar system, and also the structure of the universe on the largest scales, will be presented. Topics in cosmology will include 'Big Bang' models, the 'missing mass' problem, and the first few seconds of the universe.

Students completing this subject will be able to:

- explain the structure of the universe, and be able to apply basic principles of gravity to describe the motions of objects in the universe; and
- solve quantitative problems using these principles.

In addition students will be able to:

- participate as an effective member of an astronomy laboratory and observing group;
- communicate their understanding of astronomy orally and in written form in lab classes; and
- manage their time commitments to this subject in order to be prepared for regular lab classes as well as tests and the examination.

Assessment: A 3-hour end-of-semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent of 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: R A Freedman and W J Kaufman, *Universe*, 6th edn, Freeman, 2002.

640-177 Stars and Galaxies

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr A Melatos

Prerequisites: No formal prerequisite but a familiarity with basic physical concepts will be assumed.

Contact: Thirty-six lectures (three per week); 30 hours practical work (three hours per week) *(Semester 2)*.

Description: The application of scientific ideas to understanding objects halfway across the universe has been a great triumph of modern science. The constituents of our galaxy, in particular stars, pulsars, and supernovae, and the formation and evolution of stars and galaxies will be discussed. The final part of this subject will discuss the structures of different galaxies, the techniques used to study them, and in particular their central regions which sometimes include quasars. Particular emphasis will be given to the latest discoveries in these areas. Familiarity with basic physical concepts will be assumed.

Students completing this subject will be able to:

- explain the physical structure and life cycle of stars and galaxies; and
- solve quantitative problems using these principles.

In addition students will be able to:

- participate as an effective member of an astronomy laboratory and observing group;
- communicate their understanding of astronomy orally, in written form in lab classes, and in a multimedia environment through designing and answering web-based quizzes; and
- manage their time commitments to this subject in order to be prepared for regular lab classes as well as tests and the examination.

Assessment: A 3-hour end-of semester written examination (65%); tests totalling up to two hours and/or written assignments during the semester, up to an equivalent of 2000 words (10%); laboratory work (25%). Students must complete both laboratory and assignment work satisfactorily to obtain a pass.

Prescribed texts: R A Freedman and W J Kaufman, *Universe*, 6th edn, Freeman, 2002.

200-level subjects

640-223 Quantum Mechanics & Thermal Physics(Adv)

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr A Roberts; Dr L Hollenberg

Prerequisites: Physics 640-121 and 640-122 (or 640-141 and 640-142); and mathematics: one of [00]620-111, 620-121, 620-140, 620-141; and one of 620-113, 620-123, 620-143; or equivalent.

Pre or Corequisites: Mathematics 620-231 or 620-233 and one of [01]620-112, 620-122, 620-142, 620-211 or equivalent.

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 1)*.

Description: This subject introduces students to two fundamental areas of physics and is divided into two parts. In the quantum mechanics section, the framework of wave mechanics is established, while in thermal physics, concepts such as work, heat, temperature and entropy are introduced. The physics underlying both these components is central to an understanding of many processes in physics, chemistry and engineering.

Students completing this subject will be able to:

- explain the basic principles of quantum physics and the zeroth, first and second law of thermodynamics;
- solve and analyse simple quantum mechanical problems; and
- calculate and interpret the thermodynamic properties of several simple systems.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules to meet the deadlines for submission of assessable work and prepare for examinations.

Specific topics to be covered in the quantum mechanics section include the experimental basis of quantum mechanics; wave-particle duality, probability interpretation and the wave function; wavepackets; Schrödinger equation; one-dimensional examples such as potential steps, barriers and wells, linear momentum; operators and expectation values; an idea of three-dimensional problems and the hydrogen atom. The thermal physics section will cover the zeroth, first and second law of thermodynamics, kinetic theory, the microscopic origin of entropy, heat engines and refrigerators, paramagnetism, phase changes and chemical thermodynamics.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: R A Serway, C J Moses and C A Moyer, *Modern Physics*, Saunders. • D V Schoeder, *An Introduction to Thermal Physics*, Addison Wesley, 2000.

640-225 Electromagnetism & Relativity (Adv)

Credit points: 12.5 **HECS-band:** 2

Coordinator: Prof B H J McKellar; Dr R L Webster

Prerequisites: Physics 640-121 and 640-122 (or 640-141 and 640-142); mathematics 620-231 or 620-233 and one of 620-113, 620-123 or 620-143; or equivalent.

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 2)*.

Description: The electromagnetism section of this subject will introduce students to Maxwell's equations in differential form. These equations provide a unified understanding of electrical, magnetic and optical phenomena as well as playing a pivotal role in science and engineering. The other section of this subject will explore Einstein's Special Theory of Relativity and its role in explaining concepts such as motion, space, time and mass.

Students completing this subject will be able to:

- explain the physical basis behind Maxwell's equations and the basic principles of Einstein's theory of special relativity;
- solve and analyse simple problems in electromagnetism by applying Maxwell's equations; and
- apply the principle of special relativity to simple problems, including the analysis of collisions and other phenomena involving high-speed particles.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Content includes scalar and vector potentials; dielectric and magnetic materials: field vectors; boundary conditions; magnetic circuits; energy density of electric and magnetic fields; boundary value problems; and electromagnetic waves; inertial frames; Einstein's postulates; Lorentz transformations; modifications to kinematics and Newtonian mechanics; causality and the speed of light as the limiting speed; four-vector formulation; high energy collisions; experimental tests; and introduction to the equivalence principle and general relativity.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: R H Good, *Classical Electromagnetism*, Saunders. • E F Taylor and J A Wheeler, *Spacetime Physics*, 2nd edn, Freeman.

640-234 Further Classical & Quantum Mechanics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Prof G N Taylor; Dr D N Jamieson

Prerequisites: Physics 640-223 or 640-243.

Pre or Corequisites: Mathematics 620-231 or 620-233.

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 2)*.

Description: This subject is in two parts. Half of the subject deals with the powerful and elegant Lagrangian and Hamiltonian formulations of classical mechanics. As well as supplying new tools for problems in classical mechan-

ics, these approaches also lead to deeper insights into the relationship between classical and quantum mechanics. Lagrangian dynamics is a valuable precursor to honours-level studies in theoretical physics. The other half of the subject deals with the further development of quantum mechanics, especially in relation to three-dimensional problems and the structure of matter.

Students completing this subject will be able to:

- explain the basic principles of the Lagrangian and Hamiltonian formulations of classical mechanics as well as the present-day microscopic picture of matter in terms of its basic constituents, ranging from atoms, molecules and solids to atomic nuclei and their constituent particles;
- apply Lagrangian and Hamiltonian techniques to the solution of some key problems in classical physics; and
- solve problems in quantum mechanics relevant to the hydrogen atom and other three-dimensional problems.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Topics include review of Newtonian mechanics; Lagrangian formulation: constraints, generalised coordinates, Lagrange's equations; Hamilton's variational principle; Hamiltonian formulation: conjugate momenta, Hamilton's equations, phase space, Poisson brackets; the Hamiltonian in quantum theory; spherical harmonics and angular momentum, hydrogen atom; introduction to many-electron atoms, Pauli Principle and intrinsic spin; and quantum statistical physics.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: A P Arya, *Introduction to Classical Mechanics*, Allyn and Bacon. • R A Serway, C J Moses and C A Moyer, *Modern Physics*, Saunders.

640-237 Astrophysics & Optics II

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr V N Gurarie

Prerequisites: Physics 640-121 and 640-122 (or 640-141 and 640-142); mathematics: one of [00]620-111, 620-121, 620-140, 620-141 or equivalent.

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 1)*.

Description: This subject provides an introduction to two major areas of modern physics. In astrophysics, the basic structure of stars, our galaxy and the universe will be discussed, and the most recent research questions will be introduced. In optics, the nature and propagation of light will be explored, and illustrated by applications in modern instruments such as X-ray telescopes and lasers.

Students completing this subject will be able to:

- explain and describe the structure and evolution of stars, the structure of the Milky Way and other cosmic objects and discuss cosmological models;
- explain the geometric and wave theories of optics and their application to instrumentation;
- solve and analyse problems relevant to the above topics; and
- use the wave theory of light to calculate and interpret diffraction patterns.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: E Hecht, *Optics*, 2nd edn, Addison-Wesley. • B Carol and D Ostlie, *An Introduction to Modern Astrophysics*, Addison-Wesley.

640-243 Quantum Mechanics & Thermal Physics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr J McCallum

Prerequisites: Physics 640-121 and 640-122 (or 640-141 and 640-142); mathematics: one of [00]620-111, 620-121, 620-140, 620-141 or equivalent.

Pre or Corequisites: Mathematics: one of [01]620-112, 620-122, 620-142, 620-211; and one of 620-113, 620-123 or 620-143.

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 1)*.

Description: This subject introduces students to two fundamental areas of physics and is divided into two parts. In the quantum mechanics section, the framework of wave mechanics is established, while in thermal physics, concepts such as work, heat, temperature and entropy are introduced. The physics underlying both these components is central to an understanding of many processes in physics, chemistry and engineering.

Students completing this subject will be able to:

- explain the basic principles of quantum physics and the zeroth, first and second law of thermodynamics;
- solve and analyse simple quantum mechanical problems; and
- calculate and interpret the thermodynamic properties of several simple systems.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules to meet the deadlines for submission of assessable work and prepare for examinations.

Specific topics to be covered in the quantum mechanics section include the experimental basis of quantum mechanics; wave-particle duality, probability interpretation and the wave function; wavepackets; Schrödinger equation; one-dimensional examples such as potential steps, barriers and wells, linear momentum; operators and expectation values; an idea of three-dimensional problems and the hydrogen atom. The thermal physics section will cover the zeroth, first and second law of thermodynamics, kinetic theory, the microscopic origin of entropy, heat engines and refrigerators, paramagnetism, phase changes and chemical thermodynamics.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: R A Serway, C J Moses and C A Moyer, *Modern Physics*, Saunders. • D V Schroeder, *An Introduction to Thermal Physics*, Addison Wesley, 2000.

640-245 Electromagnetism & Relativity

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr C Chantler; Dr D N Jamieson

Prerequisites: Physics 640-121 and 640-122 (or 640-141 and 640-142); one of mathematics 620-113, 620-123 or 620-143, or equivalent.

Pre or Corequisites: Mathematics 620-231 or 620-233, or equivalent

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 2)*.

Description: The electromagnetism section of this subject will introduce students to Maxwell's equations in differential form. These equations provide a unified understanding of electrical, magnetic and optical phenomena as well as playing a pivotal role in science and engineering. The other section of this subject will explore Einstein's Special Theory of Relativity and its role in explaining concepts such as motion, space, time and mass.

Students completing this subject will be able to:

- explain the physical basis behind Maxwell's equations and the basic principles of Einstein's theory of special relativity;
- solve and analyse simple problems in electromagnetism by applying Maxwell's equations; and
- apply the principle of special relativity to simple problems, including the analysis of collisions and other phenomena involving high-speed particles.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Content includes scalar and vector potentials; dielectric and magnetic materials: field vectors; boundary conditions; magnetic circuits; energy density of electric and magnetic fields; boundary value problems; and electromagnetic waves; inertial frames; Einstein's postulates; Lorentz transformations; modifications to kinematics and Newtonian mechanics; causality and the speed of light as the limiting speed; four-vector formulation; high energy collisions; experimental tests; introduction to the equivalence principle and general relativity.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: R H Good, *Classical Electromagnetism*, Saunders. • E F Taylor and J A Wheeler, *Spacetime Physics*, 2nd edn, Freeman.

640-251 Instrumentation for Scientists

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr R Rassool

Prerequisites: Any two semesters of first year physics: physics (640-121 and 640-122) or (640-141 and 640-142) or (640-151 and 640-152) or (640-161

and 640-162); mathematics: one of [00]620-111, 620-121, 620-140, 620-141, 620-151, (620-161 and [99]620-162) or equivalent.

Contact: Twenty-four lectures and seminars (two per week) and 48 hours laboratory (a 1-hour and a 3-hour lab per week) *(Semester 1).*

Description: This subject presents the basic principles and modern techniques of instrumentation and data acquisition and presentation that are now commonly used by experimental scientists.

The lectures are supported by a highly integrated laboratory program in which students develop skills in designing and computer interfacing experiments. Students are able to suit the laboratory program to their own needs by drawing on those particular laboratory exercises of relevance to their field, such as the physical, biomedical or environmental sciences.

In the subject, elementary DC theory will be revised and extended to AC. The operational amplifier, which plays a key role in instrumentation, will be introduced together with its control by negative and positive feedback.

Students completing this subject will be able to:

- demonstrate an understanding of elementary DC and AC theory and explain the principles of sensors, transducers and actuators;
- demonstrate an understanding of and be able to implement techniques for noise reduction and signal processing;
- design and implement computer interfaces to simple experiments; and
- analyse and interpret data.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials and in a laboratory environment; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Assessment: A 2-hour end-of-semester written examination (50%); practical work (50%).

640-261 Energy and Environment

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr R Rassool

Prerequisites: At least one secondary school final-year mathematics subject and some knowledge of physics.

Contact: Thirty-six lectures and 12 one-hour tutorials *(Semester 1).*

Description: This is an introductory course in the major issues of energy use, its impact on the environment and a sustainable future. The structure of the course will suit students who wish to take a single, stand-alone course, but will also provide a valuable base for those intending to do further studies in environmental science.

Students completing this subject will be able to:

- explain the physical processes involved in various environmental issues including human environmental impact, demographics, biodiversity, energy and food production and consumption, pollution and environmental impact, climate change and renewable resources and
- analyse and interpret the results of computer models and calculations.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for examinations.

Students will learn the basic science of the physical processes involved in various environmental issues of current relevance in the global context. As part of the assessment, students will work on a project in a chosen area of study, as well as run computer models and work on problems in practice classes.

Assessment: A 2000-3000 word written report on project work (50%) and a 2-hour end-of-semester examination (50%).

640-299 Laboratory Work

Credit points: 12.5 **HECS-band:** 2

Coordinator: Ms T Mackin

Prerequisites: Physics 640-121 and 640-122 (or 640-141 and 640-142).

Contact: Seventy-two hours laboratory work (six hours per week) *(Semester 2).*

Description: This subject develops students' skills in experimental physics within the areas of optics, acoustics, nuclear and classical physics.

Students completing this subject will be able to:

- demonstrate an understanding of a wide variety of experimental and data analysis techniques;
- apply critical reasoning to the evaluation of experimental data and sources of experimental uncertainty;
- use experimental log books effectively; and
- present clearly the results of experimental work.

In addition students will enhance their ability to:

- participate effectively in a laboratory environment and be able to work as part of a team; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work.

Assessment: Laboratory participation, record keeping and reports totalling to an equivalent of no more than 3000 words assessed continuously throughout the semester. (100%)

300-level subjects

640-310 Physics - Undergraduate Seminar#

Note: All students specialising in physics must enrol in this subject.

HECS-band: 2

Coordinator: Prof B H J McKellar; Prof G N Taylor

Contact: Twenty-four one-hour seminars *(Year long).*

Description: This weekly seminar series is presented by speakers including professional physicists working in industrial or government research, those who have physics qualifications who have made careers outside mainstream physics and staff within the School of Physics discussing their own research and recent advances in physics. This subject provides an opportunity for students to broaden their outlook on physics and is invaluable for students undertaking a major in physics.

Students completing this subject will be able to:

- demonstrate an appreciation of the wide range of career options open to physicists;
- discuss the benefits of a physics education in a range of more general careers; and
- demonstrate an appreciation of the pivotal role that research plays in the School of Physics and the advancement of the discipline.

640-321 Quantum Mechanics (Adv)

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr R R Volkas

Prerequisites: Physics 640-223 or 640-243; mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234

Contact: Thirty lectures, six one-hour tutorials and up to six additional contact hours *(Semester 1).*

Description: Quantum mechanics plays a central role in our understanding of fundamental phenomena primarily in the microscopic domain. It lays the foundation for an understanding of atomic, molecular, condensed matter, nuclear and particle physics.

Students completing this subject will be able to:

- explain important concepts in quantum physics including the probability interpretation, the Heisenberg uncertainty principle, conservation laws and spin;
- solve problems applying quantum mechanical theory to situations involving atoms, molecules, solids, nuclei and elementary particles; and
- analyse solutions to predict measurable quantities.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Topics covered include the probability interpretation, time evolution and the Schrödinger equation, Fourier transforms, Hermitian operators, the eigenvalue problem, expectation values, the Heisenberg uncertainty principle and commutation relations, symmetries and conservation laws, the Dirac delta-function. The quantum mechanics of angular momentum is developed and then applied to central force systems such as the hydrogen atom. The energy eigenstates of the one-dimensional harmonic oscillator are also analysed. The physics of spin-1/2 particles is developed using the matrix theory of spin. The Hilbert space or state vector formulation of quantum mechanics is developed and Dirac bra-ket notation introduced. Time-independent perturbation theory is introduced.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: B H Bransden and C J Joachain, *Introduction to Quantum Mechanics*, Longmans. **or** E Merzbacher, *Quantum Mechanics*, Wiley.

640-322 Thermal Physics (Adv)

Credit points: 12.5 **HECS-band:** 2

Coordinator: Prof B H J McKellar

Prerequisites: Physics 640-223 or 640-243. (Prior to 1999: Physics 640-246 or 640-226.)

Contact: Thirty lectures, six one-hour tutorials and up to six additional contact hours *(Semester 1).*

Description: Statistical mechanics, the microscopic basis of classical thermodynamics, is developed in this subject. It is one of the core areas of physics, finding wide application in solid state physics, astrophysics, plasma physics and cosmology.

Students completing this subject will be able to:

- explain the statistical basis of the second and third laws of thermodynamics and the application of statistical mechanics to a range of problems in physics;
- calculate statistical and thermodynamic functions using the canonical, micro-canonical and grand-canonical ensembles; and
- analyse and interpret mathematical expressions obtained in these calculations.

In addition, students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Using fundamental ideas from quantum physics, a systematic treatment of statistical mechanics is developed for systems in equilibrium. The content of this subject includes ensembles and the basic postulate; the statistical basis of the second and third laws of thermodynamics; canonical, micro-canonical and grand-canonical ensembles and associated statistical and thermodynamic functions; ideal quantum gases; black body radiation; the classical limit and an introduction to real gases; applications to solid state physics; the Boltzmann equation and an introduction to kinetic theory.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: D J Amit and Y Verbin, *Statistical Physics: An Introductory Course,* World Scientific.

640-323 Electrodynamics (Adv)

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr A Melatos

Prerequisites: Physics 640-225 or 640-245; mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234.

Contact: Thirty lectures, six one-hour tutorials and up to six additional contact hours *(Semester 2).*

Description: This subject provides an introduction to electrodynamics and looks at a wide range of applications including optical fibres, superconductors, plasmas, and astrophysics.

Students completing this subject will be able to:

- explain classical electrodynamics based on Maxwell's equations including its formulation in covariant form;
- solve problems involving the calculation of fields, the motion of charged particles and the production of electromagnetic waves; and
- analyse the solution of these problems in the context of a range of applications.

In addition, students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

The subject provides an introduction to electrodynamics in vacuo: in terms of both fields and potentials; relativistic covariance; electrodynamics in material media: dielectric, magnetic, conducting; calculation of fields, boundary value problems: motion of particles in electromagnetic fields; production, propagation, and interaction of electromagnetic waves; radiation from accelerated charges; and Lagrangian and Hamiltonian formulation of particle motion in a field and of the field itself.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: J D Jackson, *Classical Electrodynamics,* 3rd edn, Wiley.

640-341 Quantum Mechanics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr G C Joshi

Prerequisites: Physics 640-223 or 640-243; mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234.

Contact: Thirty lectures, six one-hour tutorials and up to six additional contact hours *(Semester 1).*

Description: Quantum mechanics plays a central role in our understanding of fundamental phenomena primarily in the microscopic domain. It lays the foundation for an understanding of atomic, molecular, condensed matter, nuclear and particle physics.

Students completing this subject will be able to:

- explain important concepts in quantum physics including the probability interpretation, the Heisenberg uncertainty principle, conservation laws and spin;
- solve problems applying quantum mechanical theory to situations involving atoms, molecules, solids, nuclei and elementary particles; and
- analyse solutions to predict measurable quantities.

In addition students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Topics covered include the probability interpretation, time evolution and the Schrödinger equation, Fourier transforms, Hermitian operators, the eigenvalue problem, expectation values, the Heisenberg uncertainty principle and commutation relations, symmetries and conservation laws, the Dirac delta-function. The quantum mechanics of angular momentum is developed and then applied to central force systems such as the hydrogen atom. The energy eigenstates of the one-dimensional harmonic oscillator are also analysed. The physics of spin-1/2 particles is developed using the matrix theory of spin. The Hilbert space or state vector formulation of quantum mechanics is developed and Dirac bra-ket notation introduced. Time-independent perturbation theory is introduced.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: B H Bransden and C J Joachain, *Introduction to Quantum Mechanics,* Longmans, 1990. **or** E Merzbacher, *Quantum Mechanics,* Wiley.

640-342 Thermal Physics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr K Amos

Prerequisites: Physics 640-223 or 640-243. (Prior to 1999: physics 640-246 or 640-226.)

Contact: Thirty lectures, six one-hour tutorials and up to six additional contact hours *(Semester 1).*

Description: Statistical mechanics, the microscopic basis of classical thermodynamics, is developed in this subject. It is one of the core areas of physics, finding wide application in solid state physics, astrophysics, plasma physics and cosmology.

Students completing this subject will be able to:

- explain the statistical basis of the second and third laws of thermodynamics and the application of statistical mechanics to a range of problems in physics;
- calculate statistical and thermodynamic functions using the canonical, micro-canonical and grand-canonical ensembles; and
- analyse and interpret mathematical expressions obtained in these calculations.

In addition, students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Using fundamental ideas from quantum physics, a systematic treatment of statistical mechanics is developed for systems in equilibrium. The content of this subject includes ensembles and the basic postulate; the statistical basis of the second and third laws of thermodynamics; canonical, micro-canonical and grand-canonical ensembles and associated statistical and thermodynamic functions; ideal quantum gases; black body radiation; the classical limit and an introduction to real gases; applications to solid state physics.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: D J Amit and Y Verbin, *Statistical Physics: An Introductory Course,* World Scientific.

640-343 Electrodynamics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr M E Sevior

Prerequisites: Physics 640-225 or 640-245; mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234.

Contact: Thirty lectures, six one-hour tutorials and up to six additional contact hours *(Semester 2).*

Description: This subject provides an introduction to electrodynamics and looks at a wide range of applications including optical fibres, superconductors, plasmas, and astrophysics.

Students completing this subject will be able to:

- explain classical electrodynamics based on Maxwell's equations including its formulation in covariant form;
- solve problems involving the calculation of fields, the motion of charged particles and the production of electromagnetic waves; and
- analyse the solution of these problems in the context of a range of applications.

In addition, students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

The subject provides an introduction to electrodynamics in vacuo: in terms of both fields and potentials; relativistic covariance; electrodynamics in material media: dielectric, magnetic, conducting; calculation of fields, boundary value problems: motion of particles in electromagnetic fields; production, propagation, and interaction of electromagnetic waves.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: P Lorrain, D R Corson and F Lorrain, *Electromagnetic Fields and Waves*, 3rd edn, Freeman. **or** D J Griffiths, *Introduction to Electrodynamics*, 2nd edn, Prentice-Hall, 1989.

640-351 Astrophysics & Optics III

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr R L Webster; Prof K A Nugent

Prerequisites: Physics 640-237; (Prior to 1999: physics 640-247 or 640-227) mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234.

Contact: Thirty-six lectures *(Semester 1).*

Description: This subject develops the study of astrophysics and optics and introduces powerful mathematical tools of more general applicability in engineering and the physical sciences. In astrophysics this subject will concentrate on emission processes, higher-energy astrophysics and cosmology, while the other section of the subject provides an introduction to Fourier optics and laser physics.

Students completing this subject will be able to:

- explain emission processes in astrophysics and the application of cosmology to quasars, degenerate stars and black holes;
- calculate diffraction patterns using Fourier optics and interpret the results; and
- explain the fundamentals of laser physics.

In addition, students will enhance their ability to plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Topics in astrophysics include radiation processes, degenerate stars, black holes, accretion processes and relativisitic cosmology. Subject content in optics includes the physical optics formalism for diffraction and imaging, Fourier transforms and convolution integrals to describe Fraunhofer diffraction and the physics of lasers and their applications.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: E Hecht, *Optics*, 2nd edn, Addison-Wesley. • B Carol and D Ostlie, *An Introduction to Modern Astrophysics*, Addison-Wesley.

640-353 Atomic, Molecular & Solid State Physics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr L J Allen

Prerequisites: Physics 640-341 or 640-321

Contact: Thirty lectures, six one-hour tutorials *(Semester 2).*

Description: Quantum mechanics governs the structure of atomic, molecular and solid state systems, the nature of light and charge, and the interactions between these systems. Whereas earlier subjects detailed the principles and foundations of quantum mechanics, this subject details properties of real systems and discusses applications of this fundamental field of enquiry. The necessary use of quantum ideas in developing an understanding of the structure of matter is emphasised.

Students completing this subject will be able to:

- explain the role that quantum mechanics plays in a range of real physical systems;
- apply quantum mechanics to solve problems in a variety of physical systems; and
- interpret the solutions to these problems.

In addition, students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

The content of this subject includes aspects of the following: systems of identical particles, symmetrisation and antisymmetrisation, the Pauli exclusion principle and applications; the helium atom; degenerate perturbation theory; an introduction to many-electron atoms; fine and hyperfine structure; atoms in static external fields, the Stark and Zeeman effects, magnetism; time-dependent perturbation theory, electromagnetic transitions in atoms, spectroscopy and lasers; exponential decay and barrier penetration; an introduction to molecules and chemical bonds; crystal bonding and structure; crystal imperfections and mechanical properties; lattice vibrations and thermal properties; band theory of electrons: metals, insulators and semiconductors; dielectric and magnetic properties of solids; and superconductivity.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: B H Bransden and C J Joachain, *Physics of Atoms and Molecules*, Longman, 1983. • C Kittel, *Introduction to Solid State Physics*, 6th edn, Wiley.

640-354 Nuclear and Particle Physics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Prof B H J McKellar; Dr M N Thompson

Prerequisites: Physics 640-223 or 640-243

Contact: Thirty-six lectures *(Semester 2).*

Description: The subject provides an introduction to the modern picture of the atomic nucleus and elementary particle physics.

Students completing this subject will be able to:

- explain the modern picture of the atomic nucleus and the physics of elementary particles; and
- solve and analyse problems in these areas by applying simple quantum mechanical reasoning.

In addition, students will enhance their ability to plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

Topics covered include static nuclear properties; nuclear stability; the two nucleon problem; nuclear models for structure and reactions; alpha-decay; beta-decay; gamma-ray transitions; the quark model of hadrons; charged-lepton and neutrino physics; strong and weak interactions; symmetries and conservations laws; and experimental methods in particle physics.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

Prescribed texts: W S C Williams, *Nuclear and Particle Physics*, Clarendon Oxford.

640-356 Theoretical Methods for Physics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr L J Allen

Prerequisites: Mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234; physics 640-223 or 640-243, and physics 640-225 or 640-245.

Contact: Twenty-four lectures and 12 tutorials *(Semester 1).*

Description: This subject covers a variety of techniques for solving a range of generic problems in physics. It underpins other physics subjects and is invaluable preparation for students considering further studies in physics.

Students completing this subject will be able to:

- explain how physics problems are formulated, analysed and solved using a wide range of theoretical methods; and
- solve problems by applying these methods to a wide range of physical situations.

In addition, students will enhance their ability to:

- participate effectively as part of a group in tutorials; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and prepare for tests and examinations.

This subject provides an introduction to linear systems: time and frequency representation, natural modes of coupled systems, Fourier, Laplace, Mellin

and Hankel transform techniques, stability and causality; symmetry in physical systems: group theory and physical applications - angular momentum, isospin, crystallography; potential theory for electrostatics, magnetostatics and gravitation in two and three dimensions: solution by functions of a complex variable, Bessel and Legendre functions, Green functions, integral equations; and waves and diffusion in one-, two- and three-dimensional continuous and discrete spaces: strings, lattices, drum skins, acoustics and heat conduction.

Assessment: A 3-hour end-of-semester written examination; plus tests totalling up to two hours and/or projects and/or assignments totalling up to an equivalent of no more than 3000 words, set during the semester and which may account for up to 20% of the final mark.

640-364 Computational Physics

Credit points: 12.5 **HECS-band:** 2

Coordinator: Dr C T Chantler

Prerequisites: Physics 640-321 or 640-341; mathematics 620-231 or 620-233; and mathematics 620-232 or 620-234.

Contact: Twelve lectures; 24 hours of practice classes (two hours per week); and up to 48 hours project work *(Semester 2).*

Description: This subject will introduce students to the use of computational techniques in the investigation of a wide class of problems in physics. Using professional computing tools, students will learn programming and a range of numerical methods commonly used in physics research and apply these techniques to the investigation of physical systems through the completion of projects.

No prior computing experience is necessary.

Students completing this subject will be able to:

- explain the application of a variety of computational techniques including differencing, root finding, quadrature, ordinary and partial differential equations, matrix eigenvalue problems, Monte Carlo methods and fast Fourier transforms to physical problems; and
- apply these methods to a range of physical situations

In addition, students will enhance their ability to:

- participate effectively as part of a group; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work.

Four projects will be based on model problems in physics: molecular vibrations, stellar structure, quantum spin systems, large-scale magnetic systems. Students will also complete a research style project based on one of a choice of topics from the research groups within the School of Physics, including universality in the Ising model, Fourier analysis and computer-aided tomography (CAT), many electron atoms, hydrodynamics, interaction of radiation with matter, gravitational lensing by point masses, atom optics.

Assessment: Five computer-based projects during the semester totalling to an equivalent of no more than 8000 words (not including program listings and diagrams) (100%).

Prescribed texts: R H Landau and M J Páez, *Computational Physics: Problem Solving with Computers,* Wiley.

640-381 Principles and Applications of Sensors

Credit points: 12.5 **HECS-band:** 2

Coordinator: Prof S Prawer; Dr M E Sevior

Prerequisites: Physics 640-141 plus 640-142 or 640-121 plus 640-122 or equivalent

Corequisites: Electrical engineering 431-330 or physics 640-251 or equivalent

Contact: Twenty-four hours of lectures; 12 hours of tutorials; 12 hours of practical laboratory class *(Semester 2).*

Description: This subject integrates the principles of physics and electrical engineering to introduce students to sensor technology. Students completing this subject will be able to:

- explain the fundamentals of the operation of sensors and transducers for the measurement of temperature, pressure, light, stress, composition, fatigue and the chemical environment; and
- design a solution to a particular sensing problem based on their knowledge of the physical principles underpinning the operation of each type of sensor.

In addition, students will enhance their ability to:

- participate effectively in a laboratory environment and be able to work on a project as part of a team; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work and preparation for tests and the examination.

Topics to be covered include the basic principles of the quantum theory of atoms, molecules and solids and the application of these principles to a wide range of materials which are of key importance in modern electronics and technology. In addition to the fundamental concepts, topics to be covered include an introduction to various types of sensors and the basic physical phenomena underpinning their operation.

Assessment: A 3-hour examination (50%), projects totalling to an equivalent of no more than 3000 words (30%) and laboratory work (20%).

640-393 Laboratory Work

Note: The standard laboratory sequence taken by most students specialising in physics and wishing to proceed to honours-level studies in physics totals 25 points. This is usually achieved by completing 640-393 and 640-394.

Credit points: 12.5 **HECS-band:** 2

Coordinator: Ms T Mackin

Prerequisites: Physics 640-299.

Contact: Six weeks (a week is made up of three days x four hours per day = 12 hours of work) *(Semester 1).*

Description: Students completing this subject will be able to:

- demonstrate an understanding of a wide variety of advanced experimental and data analysis techniques;
- acquire, analyse and interpret experimental data; and
- write and evaluate scientific and technical reports.

In addition, students will enhance their ability to:

- participate effectively in a laboratory environment and be able to work as part of a team; and
- plan effective work schedules and manage their time to meet the deadlines for submission of assessable work.

The two subjects 640-393 and 640-394 consist of laboratory work drawn from a common pool of experiments. Practical experience is available in the following laboratories: nuclear physics, particle physics, diffraction, electronics, atomic physics, optical physics, astronomy. Workshop experience is also available; in some laboratories individual projects can be selected.

Assessment: Laboratory participation, record keeping and two to three reports totalling up to an equivalent of no more than 5000 words assessed continuously throughout the semester. (100%)

640-394 Laboratory Work

Credit points: 12.5 **HECS-band:** 2

Coordinator: Ms T Mackin

Prerequisites: Physics 640-299.

Contact: Six weeks (a week is made up of three days x four hours per day = 12 hours of work) *(Semester 2).*

Additional details as for 640-393 Laboratory Work *(p.9)*.