Physics

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

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

There are four 100-level physics subject streams lasting the entire year and each made up of two one-semester subjects normally taken together, plus optional subjects in astronomy. Physics 640-121 plus 640-122 and 640-141 plus 640-142 assume a knowledge of VCE Units 3 and 4 physics and elementary calculus. Physics 640-161 plus 640-162 assumes some prior knowledge of physics and mathematics but not necessarily to VCE Units 3 and 4. Physics for Biomedical Science 640-151 plus 640-152 are core subjects in the Bachelor of Biomedical Science course and assume some knowledge of physics and VCE Mathematical Methods Units 3 plus 4. The Solar System and the Cosmos 640-176 and Stars and Galaxies 640-177 are optional astronomy subjects.

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.

640-141 plus 640-142 is a physics stream providing a coverage of physics suited to students wishing to specialise in any physical, technological or biological discipline.

640-161 plus 640-162 is a physics stream giving a broader and more descriptive coverage of physics. It is designed to be a well-rounded single-year treatment of physics for students who do not have a solid background in physics and mathematics. Students with sufficiently good results in Physics 640-161 plus 640-162 and mathematics may be permitted to proceed to later year physics subjects.

640-151 plus 640-152 Physics for Biomedical Science is a stream aimed at students wishing to major in the biomedical sciences. For BSc students, entry to this subject 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.

Students who have concerns about their preparation in mathematics and physics are recommended to revise their knowledge by preliminary reading of an appropriate text, e.g. 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 V Gurarie

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 E C Spargo

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 11 640-237,
- 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 50 points of 300-level mathematics and statistics subjects selected from: Metric Spaces 620-311, Linear Analysis 620-312, Algebra 620-321, Topology 620-322, Applied Partial Differential Equations 620-331, Integral Transforms and Asymptotics 620-332, Dynamical Systems of Chaos 620-341, Industrial and Applied Mathematics 620-342 with additional subjects selected from

300-level Physics and, optionally, 300-level Mathematics or 300-level Chemistry.

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.883)*. These requirements should be considered when planning your course.

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 S N Tovey

Prerequisites: Physics and two mathematics subjects, at the level of the final year of secondary school. Students who have completed the VCE will usually satisfy these requirements by having done Units 3 and 4 of Physics, Units 3 and 4 of Mathematical Methods and Units 3 and 4 of Specialist Mathematics.

Contact: 36 lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 1)*.

Description: By the completion of this subject the student should:

- comprehend a broad range of elementary physics sufficient to lay a basis for advanced higher year studies in physics;
- have developed skills in applying verbal and mathematical reasoning to the understanding of elementary physical systems and in acquiring and evaluating experimental data; and
- appreciate the power and depth of physical theory in a wide range of science and technology.

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; and heat transfer.

Assessment: A 3-hour written examination at the end of the semester (65%); tests and/or written assignments totalling one hour during the semester (10%); laboratory work (25%). Students must satisfactorily complete both laboratory and assignment work to obtain a pass.

Prescribed texts: H C Ohanian H C, *Physics*, 2nd expanded ed., Norton, 1989.

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: Prof G N Taylor

Prerequisites: Physics and two mathematics subjects, at the level of the final year of secondary school. Students who have completed the VCE will usually satisfy these requirements by having done Units 3 and 4 of Physics, Units 3 and 4 of Mathematical Methods and Units 3 and 4 of Specialist Mathematics. It will be assumed that students are familiar with the content of Physics 640-121.

Contact: 36 lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 2)*.

Description: By the completion of this subject the student should:

- comprehend a broad range of elementary physics sufficient to lay a basis for advanced higher year studies in physics;
- have developed skills in applying verbal and mathematical reasoning to the understanding of elementary physical systems and in acquiring and evaluating experimental data; and
- appreciate the power and depth of physical theory in a wide range of science and technology.

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; atomic and nuclear physics: atomic and nuclear structure, X-rays, radioactivity, and nuclear radiations, fission and fusion; and nuclear power.

Assessment: A 3-hour written examination at the end of the semester (65%); written tests and/or assignments totalling 1 hour during the semester (10%); laboratory work (25%). Students must complete satisfactorily both laboratory and assignment work to obtain a pass.

Prescribed texts: H C Ohanian, *Physics*, 2nd expanded ed., Norton, 1989.

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 N Thompson

Prerequisites: Physics and mathematics (two mathematics subjects are recommended) from the final year of secondary school. Students who have completed the VCE will often satisfy these requirements by having done Units 3 and 4 of Physics, Units 3 and 4 of Mathematical Methods and Units 3 and 4 of Specialist Mathematics. Students without Specialist Mathematics may enrol in this subject.

Contact: 36 lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 1)*.

Description: By the completion of this subject the student should:

- comprehend a broad range of elementary physics sufficient to lay a basis for higher year studies in physics;
- have developed skills in applying verbal and mathematical reasoning to the understanding of elementary physical systems and in acquiring and evaluating experimental data; and
- appreciate the power and depth of physical theory in a wide range of science and technology.

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

Assessment: A 3-hour written examination at the end of the semester (65%); tests and/or written assignments totalling 1 hour during the semester (10%); laboratory work (25%). Students must complete satisfactorily both laboratory and assignment work to obtain a pass.

Prescribed texts: D Halliday, R Resnick and J Walker, *Fundamentals of Physics*, 6th extended ed., 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 R Scholten

Prerequisites: Physics and mathematics (two mathematics subjects are recommended) from the final year of secondary school. Students who have completed the VCE will often satisfy these requirements by having done Units 3 and 4 of Physics, Units 3 and 4 of Mathematical Methods and Units 3 and 4 of Specialist Mathematics. Students without Specialist Mathematics may enrol in this subject. It will be assumed that students are familiar with the content of 640-141 Physics A *(p.862)*.

Contact: 36 lectures (three per week), 12 1-hour tutorials and 30 hours practical work (three hours per week) *(Semester 2)*.

Description: By the completion of this subject the student should:

- comprehend a broad range of elementary physics sufficient to lay a basis for higher year studies in physics;
- have developed skills in applying verbal and mathematical reasoning to the understanding of elementary physical systems and in acquiring and evaluating experimental data; and
- appreciate the power and depth of physical theory in a wide range of science and technology.

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 written examination at the end of the semester (65%); tests and/or written assignments totalling 1 hour during the semester (10%); laboratory work (25%). Students must complete satisfactorily both laboratory and assignment work satisfactorily to obtain a pass.

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

640-151 Physics for Biomedical Science A

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 A Roberts

Prerequisites: Some knowledge of physics, VCE Mathematical Methods 3/4 (or an equivalent subject). For BSc students, entry to this subject will be by invitation of the head of the School of Physics, usually requiring a very high level of achievement in the final year of secondary school.

Contact: 36 lectures (three per week), 12 1-hour tutorials (one per week), laboratory work and reading assignment(s) involving 36 hours work during the semester *(Semester 1).*

Description: An understanding of physics is essential to the description of many biological processes and the development of modern medical science and technology. This is the first subject of a two-semester sequence which will develop students' appreciation of the importance of physical principles to biomedical science as well as their understanding of the principles underpinning human structure and function, medical diagnostics and therapeutics.

The subject provides an introduction to several areas: acoustics: hearing, speech, ultrasound imaging, therapeutic applications of sound (properties of waves, the nature of sound, superposition of waves, Doppler effect, interaction of sound with matter); optics: optical imaging and sensing and human and animal vision (reflection, refraction and dispersion of light, mirrors and images, optical fibres, lenses, optical imaging and optical instruments); atomic physics and lasers: fluorescence imaging and spectroscopy, laser surgery (structure of the atom, photons, spectroscopy, interaction of light with matter); and mechanics: human and animal movement, sport, injuries (Newton's laws of motion, energy transfer and transformation, mechanical properties of materials, elasticity, compression and extension).

Assessment: A 3-hour end-of-semester examination (65%); laboratory work together with a group project (25%); tests totalling 1 hour during the semester (10%). Students must complete satisfactorily both laboratory and project work to obtain a pass.

Prescribed texts: R A Serway, *Principles of Physics*, 2nd ed., Saunders, 1994. • J Faughn, *Life Science Applications for Physics*, Harcourt Brace, 1994.

640-152 Physics for Biomedical Science B

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 D N Jamieson

Prerequisites: It will be assumed that students are familiar with the content of 640-151 Physics for Biomedical Science A *(p.863)*. Some knowledge of physics, VCE Mathematical Methods 3/4 (or an equivalent subject). For BSc students, entry to this subject will be by invitation of the Head of the School of Physics, usually requiring a very high level of achievement in the final year of secondary school.

Contact: 36 lectures (three per week), 12 1-hour tutorials (one per week), laboratory work and assignment(s) involving 36 hours work during the semester *(Semester 2).*

Description: An understanding of physics is essential to the description of many biological processes and the development of modern medical science and technology. This is the second subject of a two-semester sequence which will develop students' appreciation of the importance of physical principles to biomedical science as well as their understanding of the principles underpinning human structure and function, medical diagnostics and therapeutics.

The subject provides an introduction to several areas: fluids: blood flow, respiration and membranes (pressure in fluids, fluid flow, viscosity, surface tension, membranes and capillarity); thermal physics: energy balance of living organisms, movement of ions across membranes (thermal energy and temperature, thermal expansion, first law of thermodynamics, conduction, convection, radiation and exaporation, diffusion); electricity and magnetism: Bioelectricity, nerve conduction, electrical safety and instrumentation, therapeutic uses of electromagnetic waves (forces between electric charges, electric currents, magnetic forces on moving charged particles, electric circuits, resistance, capacitance, electromagnetic waves); radiation: radiation safety, carbon dating, therapeutic uses of radiation (the atomic nucleus, isotopes, nuclear decay and radiation, physical and biological half-life, ionising radiation); and imaging: modern biomedical imaging (X-rays (radiography), CT-scans and angiography, magnetic resonance and nuclear magnetic resonance imaging, positron emission tomography, gamma-ray imaging).

Assessment: A 3-hour end-of-semester examination (65%); laboratory work together with a group project (25%); tests totalling 1 hour during the semester (10%). Students must complete satisfactorily both laboratory and project work to obtain a pass.

Prescribed texts: R A Serway, *Principles of Physics*, 2nd ed., Saunders, 1994. • J Faughn, *Life Science Applications for Physics*, Harcourt Brace, 1994.

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.

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

Coordinator: Dr M Livett

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

Contact: 36 lectures (three per week), 12 one hour tutorials and 30 hours practical work (3 hours per week) *(Semester 1).*

Description: This subject forms the first part of a two-semester sequence of subjects designed for students with a minimal background in physics. It aims to provide students with an understanding of a broad range of elementary physics principles together with skills in applying these principles to a range of physical, biological and medical situations. Simple mathematics is used throughout. By completing this subject students should gain an appreciation of the value of a physics understanding in their specialist area.

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

Assessment: A 3-hour written examination at the end of the semester (65%); tests and/or written assignments totalling 1 hour during the semester (10%); laboratory work (25%). Students must complete satisfactorily both laboratory and assignment work to obtain a pass.

Prescribed texts: D C Giancoli, *Physics Principles with Applications*, 5th ed., 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.

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

Coordinator: Dr C Chantler

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.863)*.

Contact: 36 lectures (three per week), 12 1-hour tutorials and 30 hours practical work (3 hours per week) *(Semester 2).*

Description: This subject forms the second part of a two-semester sequence of subjects designed for students with a minimal background in physics. It aims to provide students with an understanding of a broad range of elementary physics principles together with skills in applying these principles to a range of physical, biological and medical situations. Simple mathematics is used throughout. By completing this subject students should gain an appreciation of the value of a physics understanding in their specialist area.

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 written examination at the end of the semester (65%); tests and/or written assignments totalling one hour during the semester (10%); laboratory work (25%). Students must complete satisfactorily both laboratory and assignment work to obtain a pass.

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

640-176 The Solar System and the Cosmos

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

Coordinator: Dr R Webster

Contact: 36 lectures (three per week); 30 hours practical work (3 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.

Assessment: A 3-hour end-of-semester written examination (75%); continuously assessed practical work (25%).

Prescribed texts: W J Kaufmann and R A Freedman, *Universe*, 5th ed., Freeman, 1999.

640-177 Stars and Galaxies

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

Coordinator: Prof G N Taylor

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

Contact: 36 lectures (three per week); 30 hours practical work (3 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 will basic physical concepts will be assumed.

Assessment: A 3-hour end-of-semester written examination (75%); continuously assessed practical work (25%).

Prescribed texts: W J Kaufmann and R A Freedman, *Universe*, 5th ed., Freeman.

200-level subjects

640-223 Quantum Mechanics & Thermal Physics(Adv)

Note: Credit cannot be gained for both 640-223 and any of 640-243, 640-226 and 640-246 listed in the 1998 Handbook.

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

Coordinator: Dr S N Tovey; Dr A Roberts

Prerequisites: Physics 640-121 plus 640-122 or 640-141 plus 640-142; and mathematics: one of 620-111, 620-121, 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 620-112, 620-122, 620-142, 620-211 or equivalent.

Contact: 36 lectures and 12 one hour tutorials *(Semester 1).*

Description: This subject introduces students to two fundamental areas of physics:

i The developments in 20th century physics which led to the formulation of wave mechanics and quantum physics. Specific topics will include the experimental basis of quantum mechanics; wave-particle duality, probability interpretation and the wave function; wavepackets and an introduction to Fourier transforms; Schrödinger equation and stationary states; one-dimensional examples: potential steps, barriers and wells, linear momentum; operators and expectation values; an idea of 3-dimensional problems and the hydrogen atom.

ii The exploration of concepts such as heat, temperature and internal energy via the classical phenomenological approach to thermal physics as well as the atomistic approach provided by kinetic theory and statistical mechanics. These developments are central to an understanding of many processes in physics, chemistry and engineering. Content includes basic concepts: thermal equilibrium and thermometry; kinetic theory and ideal gases; heat, work and the first law of thermodynamics; introduction to statistical mechanics; second law: entropy, heat engines and refrigerators; and free energy, phase changes and chemical thermodynamics.

Students will develop skills in the analytic and computational techniques required to solve problems in quantum mechanics and thermal physics.

Assessment: A 3-hour end-of-semester written examination plus tests, projects and/or assignments, set during the semester, which may account for up to 20% of the final marks.

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)

Note: Credit cannot be gained for both 640-225 and any of 640-245, 640-221 and 640-241 listed in the 1998 Handbook.

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

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

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

Contact: 36 lectures and 12 1-hour tutorials *(Semester 2).*

Description: This introduces two fundamental areas of physics:

- An introduction to Maxwell's equations in differential form. This subject will show how Maxwell's equations provide a unified understanding of electrical, magnetic and optical phenomena; how they can be applied to simple problems, including those involving dielectric and magnetic media; how they play a key role in a wide range of processes in science and engineering. Content includes scalar and vector potentials; dielectric and magnetic materials: field vectors P, D, M, H; boundary conditions for field vectors; magnetic circuits; energy density of electric and magnetic fields; simple boundary value problems; and electromagnetic waves: in vacuum and simple dielectrics, wave equations, Poynting's vector.
- Einstein's Special Theory of Relativity. The difficulties faced by physics at the end of the 19th Century and the revolution that was necessary in concepts of motion, space, time and mass will be explained. Applications to phenomena involving high speed particles will be addressed. Topics include 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; spacetime interval; high energy collisions; equivalence of mass and energy; experimental tests; and physical introduction to the equivalence principle and general relativity.

Students will develop skills in the analytic and computational techniques required to solve problems in electromagnetism and special relativity.

Assessment: A 3-hour end-of-semester written examination plus tests, projects and/or assignments, set during the semester, which may account for up to 20% of the final marks.

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

640-234 Further Classical & Quantum Mechanics

Note: Credit cannot be gained for both 640-234 and any of the subjects 640-224, 640-244, 640-229 and 640-249 listed in the 1998 Handbook.

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

Coordinator: Prof G N Taylor

Prerequisites: Physics 640-223 or 640-243.

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

Contact: 36 lectures and 12 1-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 mechanics, 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. Topics include review of Newtonian mechanics; Lagrangian formulation: constraints, generalised coordinates, Lagrange's equations; Hamilton's variational principle, the action; selected applications; Hamiltonian formulation: conjugate momenta, Hamilton's equations, phase space, Poisson brackets; and the Hamiltonian in quantum theory. 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. Topics include 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 and/or assignments, set during the semester, which may account for up to 20% of the final marks.

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

Note: Credit cannot be gained for 640-237 and either of the subjects 640-247 or 640-227 listed in the 1998 Handbook.

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

Coordinator: Dr M Drinkwater; Dr V N Gurarie

Prerequisites: 640-121 plus 640-122 or 640-141 plus 640-142; Mathematics 620-111 or 620-121 or 620-141 or equivalent.

Contact: 36 lectures and 12 1-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. Topics include demographics of the distribution of stars; the structure and evolution of stars; the structure of the Milky Way; an inventory of cosmic objects; and cosmological models. 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. The content includes a review of the mathematics of wave motion; electromagnetic waves; propagation of light; geometrical optics; wave optics, interference; and diffraction.

Assessment: A 3-hour end-of-semester written examination plus tests and/or assignments, set during the semester, which may account for up to 20% of the final marks.

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

640-243 Quantum Mechanics & Thermal Physics

Note: Credit cannot be gained for both 640-243 and any of the subjects 640-223, 640-226 and 640-246 listed in the 1998 Handbook.

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

Coordinator: Dr R Scholten

Prerequisites: Physics 640-121 plus 640-122 or 640-141 plus 640-142; Mathematics: one of 620-111, 620-121, 620-141; or equivalent.

Pre or Corequisites: One of mathematics 620-112, 620-122, 620-142, 620-211; and one of 620-113, 620-123 or 620-143.

Contact: 36 lectures and 12 1-hour tutorials *(Semester 1).*

Description: This subject introduces two fundamental areas of physics:

i The developments in 20th century physics which led to the formulation of wave mechanics and quantum physics. Specific topics will include the experimental basis of quantum mechanics; wave-particle duality, probability interpretation and the wave function; wave packets and an introduction to Fourier transforms; Schrödinger equation and stationary states; one-dimensional examples: potential steps, barriers and wells, linear momentum; operators and expectation values; and an idea of three-dimensional problems and the hydrogen atom.

ii The exploration of concepts such as heat, temperature and internal energy via the classical phenomenological approach to thermal physics as well as the atomistic approach provided by kinetic theory and statistical mechanics. These developments are central to an understanding of many processes in physics, chemistry and engineering. Content includes basic concepts: thermal equilibrium and thermometry; kinetic theory and ideal gases; heat, work and the first law of thermodynamics; introduction to statistical mechanics; second law: entropy, heat engines and refrigerators; and free energy, phase changes and thermodynamics.

Student will develop skills in the analytic and computational techniques required to solve problems in quantum mechanics and thermal physics.

Assessment: A 3-hour end-of-semester written examination plus tests, projects and/or assignments, set during the semester, which may account for up to 20% of the final marks.

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

Note: Credit cannot be gained for both 640-245 and any of the subjects 640-225, 640-221 and 640-241 listed in the 1998 Handbook.

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

Coordinator: Dr C Chantler; Dr D N Jamieson

Prerequisites: Physics 640-121 plus 640-122 or 640-141 plus 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: 36 lectures and 12 1-hour tutorials *(Semester 2).*

Description: This subject introduces two fundamental areas of physics:

- An introduction to Maxwell's equations in differential form. This subject will show how Maxwell's equations provide a unified understanding of electrical, magnetic and optical phenomena; how they can be applied to simple problems, including those involving dielectric and magnetic media; and how they play a key role in a wide range of processes in science and engineering. Content includes scalar and vector potentials; dielectric and magnetic materials: field vectors P, D, M, H; boundary conditions for field vectors; magnetic circuits; energy density of electric and magnetic fields; simple boundary value problems; and electromagnetic waves: in vacuum and simple dielectrics, wave equations, Poynting's vector.
- Einstein's Special Theory of Relativity. The difficulties faced by physics at the end of the 19th century and the revolution that was necessary in concepts of motion, space, time and mass will be explained. Applications to phenomena involving high speed particles will be addressed. Topics include 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; spacetime interval; high energy collisions; equivalence of mass and energy; experimental tests; and physical introduction to the equivalence principle and general relativity.

Students will develop skills in the analytic and computational techniques required to solve problems in electromagnetism and special relativity.

Assessment: A 3-hour end-of-semester written examination plus tests, projects and/or assignments, set during the semester, which may account for up to 20% of the final marks.

Prescribed texts: R H Good, *Classical Electromagnetism*, Saunders. • E F Taylor and J A Wheeler, *Spacetime Physics*, 2nd ed., 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 plus 640-122) or (640-141 plus 640-142) or (640-151 plus 640-152) or (640-161 plus 640-162); Mathematics 620-111 or 620-121 or 620-141 or 620-151 or (620-161 and [99]620-162) or equivalent.

Contact: 24 lectures and seminars (two per week) and 48 hours laboratory (a 1-hour and a 3-hour lab per week) *(Semester 1).*

Description: Experimental scientists need to know how to devise a set of measurements, automate experiments, and capture and manipulate signals. Furthermore, it is now commonplace to make extensive use of computers to log signals, process data and present information. This subject presents the basic principles and modern techniques of instrumentation and data acquisition and presentation.

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 course, 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. The principles of sensors, transducers and actuators will be discussed, together with techniques for unwanted signal (noise) reduction and other signal processing methods. The course concludes with a review of the available methods of data analysis and presentation using computers.

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: 36 lectures and 12 1-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 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.

Topics covered will be overview of the global problem of human environmental impact; human population growth, demographics, population dynamics; biodiversity; resource depletion; human energy requirement, food production and consumption; conventional energy production and use, fossil fuels, carbon-dioxide emissions; pollution and environmental impact, industrial waste, ozone depletion/nuclear waste; greenhouse effect, global warming and climate change; nuclear energy, fission and fusion, fast breeder reactors, reprocessing; renewable energy (solar, wind, wave, hydro, ocean thermal, geothermal, tidal, biomass) and energy storage; risk assessment, quantitative measurement and computer modelling, ecological modelling (populations, communities and ecosystems); and issues for a sustainable/survivable future.

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

640-299 Laboratory Work

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

Coordinator: Prof K A Nugent

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

Contact: 72 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. It increases students' appreciation of the central role of experiments in physics in addition to developing their understanding of the power and limitations of experimental work. By the end of the subject students should comprehend a wide variety

of experimental and data analysis techniques; be able to apply critical reasoning to the evaluation of experimental data and sources of experimental uncertainty; have acquired a high degree of skill in keeping experimental log books and in presenting the results of experimental work.

Assessment: Assessed continuously throughout the subject.

300-level subjects

640-310 Physics - Undergraduate Seminar#

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

HECS-band: 2

Coordinator: Dr M N Thompson

Contact: 24 1-hour seminars *(Year long).*

Description: By the completion of this subject the student should:

- appreciate many of the wider aspects of physics; and
- have acquired skills in the critical evaluation of oral presentations.

Typical seminar areas include recent advances in physics; the physics research scene in the School of Physics, elsewhere in Australia, and overseas; physics in industry; the efficient use of scientific literature; report and paper writing; and the impact of physics on society.

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: 30 lectures and 6 1-hour tutorials *(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, solid-state, nuclear and particle physics. By the completion of this subject the student should have a thorough grounding in the principles of quantum mechanics as they relate to both wave-mechanical and spin systems. 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 and/or assignments, set during the semester, 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: 30 lectures and 6 1-hour tutorials *(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. 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; ideal magnetic systems; applications to solid state physics.

Assessment: A 3-hour end-of-semester written examination plus test and/or assignments, set during the semester, which may account for up to 20% of the final mark.

Prescribed texts: K Huang, *Statistical Mechanics,* 2nd ed., Wiley.

640-323 Electrodynamics (Adv)

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

Coordinator: Prof G I Opat

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

Contact: 30 lectures and 6 1-hour tutorials *(Semester 2).*

Description: By the completion of this subject the student should:

- have a thorough comprehension of classical electrodynamics based on Maxwell's equations, including its formulation in covariant form;
- be able to apply this understanding to the solution of problems involving the calculation of fields (boundary value problems), the motion of charged particles, and the production and behaviour of electromagnetic waves; and
- appreciate the role of electrodynamics as the prototype of a number of more general physical theories.

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; magneto-hydrodynamics; 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; quantum aspects of electrodynamics.

Assessment: A 3-hour end-of-semester written examination plus tests and/or assignments, set during the semester, which may account for up to 20% of the final mark.

Prescribed texts: J D Jackson, *Classical Electrodynamics,* 3rd ed., 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: 30 lectures and 6 1-hour tutorials *(Semester 1).*

Description: Quantum mechanics plays a central role in our understanding of fundamental phenomena in the microscopic domain. It lays the foundation for an understanding of atomic, molecular, solid-state, nuclear and particle physics. By the completion of this subject the student should have a thorough grounding in the principles of quantum mechanics as they relate to both wave-mechanical and spin systems. 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, and 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 and/or assignments set during the semester, 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 L C L Hollenberg

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

Contact: 30 lectures and 6 1-hour tutorials *(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. 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; ideal magnetic systems; and applications to solid state systems.

Assessment: A 3-hour end-of-semester written examination plus tests and/or assignments, set during the semester, which may account for up to 20% of the final mark.

Prescribed texts: Kittel C and Kroemer H, *Thermal Physics,* 2nd ed. Freeman 1980.

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: 30 lectures and 6 1-hour tutorials *(Semester 2).*

Description: By the completion of this subject the student should:

- have a thorough comprehension of classical electrodynamics based on Maxwell's equations; and
- be able to apply this understanding to the solution of problems involving the calculation of fields (boundary value problems), the motion of charged particles, and the production and behaviour of electromagnetic waves.

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

Assessment: A 3-hour end-of-semester written examination plus tests and/or assignments, set during the semester, 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 ed., Freeman. **or** D J Griffiths, *Introduction to Electrodynamics*, 2nd ed., Prentice-Hall, 1989.

640-351 Astrophysics & Optics III

Note: Credit may not be gained for both 640-351 and the subject 640-361 listed in the 1998 Handbook.

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: 36 lectures *(Semester 1).*

Description: This subject develops the study of astrophysics and optics using more advanced mathematics. In astrophysics, the course will concentrate on emission processes, high-energy astrophysics and cosmology with applications to quasars, degenerate stars and black holes. Topics include radiation processes, degenerate stars, black holes, accretion processes and relativisitic cosmology. The second part of this subject provides an introduction to Fourier optics and its applications to actual systems such as aperture synthesis telescopes. The production and interpretation of diffraction patterns is discussed and an introduction to the fundamentals of laser physics and fibre optics presented. Subject content includes physical optics formalism for diffraction and imaging; Fourier transforms and convolution integrals to describe Fraunhofer diffraction; the physics of lasers and applications; and introduction to optical fibres.

Assessment: A 3-hour end-of-semester written examination plus test and/or assignments, set during the semester, which may account for up to 20% of the final mark.

Prescribed texts: E Hecht, *Optics*, 2nd ed., 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 S Prawer

Prerequisites: 640-341 Quantum Mechanics or 640-321 Quantum Mechanics (Advanced).

Contact: 30 lectures and 6 1-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. 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 and/or assignments, set during the semester, 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. **or** G K Woodgate, *Elementary Atomic Structure*, 2nd ed., Oxford Scientific. • C Kittel, *Introduction to Solid State Physics*, 6th ed., Wiley. **or** J R Hook and H E Hall, *Solid State Physics*, 2nd ed., Wiley.

640-354 Nuclear and Particle Physics

Note: Credit cannot be gained for both 640-354 and the subject 640-363 listed in the 1998 Handbook.

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

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

Prerequisites: Physics 640-321 or 640-341; Physics 640-225 (or the subject 640-221 listed in the 1998 Handbook) or physics 640-245 (or the subject 640-241 listed in the 1998 Handbook).

Contact: 36 lectures *(Semester 2).*

Description: This subject provides an introduction to nuclear and particle physics. By the end of this subject the student will have been introduced to the modern picture of the atomic nucleus, the physics of elementary particles and be able to apply simple quantum mechanical reasoning to these areas. The subject provides an introduction to 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 and/or assignments, set during the semester, which may account for up to 20% of the final mark.

Prescribed texts: K S Krane, *Introductory Nuclear Physics*, WileyH. **or** Enge, *Introduction to Nuclear Physics*, Addison Wesley. **or** B Cohen, *Concepts of Nuclear Physics*, McGraw-Hill. • D H Perkins, *Introduction to High Energy Physics*, 2nd ed., Addison-Wesley.

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; mathematics 620-232 or 620-234; and no less than 37.5 points of 200 level physics subjects which must include 640-223 or 640-243, and 640-225 or 640-245.

Pre or Corequisites: 640-321 or 640-341, and 640-322 or 640-342.

Contact: 24 lectures and 12 tutorials *(Not Offered).*

Description: This subject will provide students with:

- comprehension of how physics problems are formulated, analysed and solved using a wide range of theoretical methods;
- an ability to apply these methods to a wide range of physical situations; and
- a grounding in relevant theoretical methods for those with an experimental orientation.

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 2.5-hour end-of-semester written examination, plus tests and/or assignments, set during the semester, which may account for up to 20% of the final mark.

640-364 Computational Physics

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

Coordinator: Dr R Scholten

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

Contact: 12 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 tech-

niques to the investigation of physical systems through the completion of projects.

No prior computing experience is necessary.

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.

Techniques include: differencing, root finding, quadrature; ordinary and partial differential equations; matrix eigenvalue problems; Monte Carlo methods; fast Fourier transform.

Assessment: Five computer projects during semester (100%).

Prescribed texts: S E Koonin, *Computational Physics*, Benjamin/Cummings.

640-381 Principles and Applications of Sensors

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

Coordinator: Dr S Prawer

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

Corequisites: 431-330 or 640-251 or equivalent

Contact: 24 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 so that upon completion of the subject students will understand the fundamentals of the operation of sensors and transducers for the measurement of temperature, pressure, light, stress, composition, fatigue and the chemical environment. Students will be able to design a solution to a particular sensing problem based on their knowledge of the physical principles underpinning the operation of each type of sensor.

Fundamentals 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 sensor technology.

Using these fundamental ideas, the topics to be covered include introduction to various types of sensors and the basic physical phenomena underpinning their operation; chemical sensors; pressure sensors; temperature sensors (remote and contact); light sensors (including photodiodes, photomultipliers, CCD cameras, and optical fibre sensors); examples and applications; signal processing for sensor; and sources of error and limitations.

Assessment: A 3-hour examination; tutorial assignments; project and laboratory work involving the design and implementation of the solution to a particular sensing problem. Students will be advised of the relative weighting of each component at the beginning of the subject.

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: Dr L Bursill

Prerequisites: Physics 640-299.

Contact: Six weeks (a week is made up of 3 days x 4 hours per day = 12 hours of work) *(Semester 1)*.

Description: By the end of this subject the student should:

- comprehend a wide range of advanced experimental techniques;
- achieve a high level of skill in acquiring and evaluating experimental data and in writing and evaluating scientific reports; and
- appreciate the role of experimentation in physics and the need for all physicists to be able to read and critically assess reports of experimental 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: Assessed continuously throughout the subject.

640-394 Laboratory Work

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

Coordinator: Dr L Bursill

Prerequisites: Physics 640-299.

Contact: Six weeks (a week is made up of 3 days x 4 hours per day = 12 hours of work) *(Semester 2)*.

Additional details as for 640-393 Laboratory Work *(p.868)*.