Study Abroad Opportunities at La Trobe University, Melbourne
Physics and Nanotechnology

Summary of Study Abroad Units

Semester 1 – 12 weeks duration, March to June
Semester 2 – 12 weeks duration, July – October
An examination period of 3 weeks follows each semester

Undergraduate and Postgraduate Units in Physics and Nanotechnology

The units comprising a major in physics are highlighted in yellow

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Pre-requisites
Year 1							
PHY1SCA	Principles of Physics A "Physics 100"	1	1	15	36	48	None, physics or mathematics at high school level preferred
PHY1SCB	Principles of Physics B "Physics 100"	2	1	15	36	48	None, physics or mathematics at high school level preferred
PHY1LSA Y	Physics for Life Sciences A	1	1	15	36	48	None
PHY1LSB Y	Physics for Life Sciences B	2	1	15	36	48	None
PHY1AST Y	Astronomy and Space: The Infinite Frontier	2	1	15	24	36	None
Year 2							
PHY2EMM	Electromagnetism and Modern Materials	2	2	15	24	48	Equivalent of first year physics
PHY2MOD	Modern Physics	2	2	15	24	48	Equivalent of first year physics
PHY2OPT	Optics	1	2	15	24	48	Equivalent of first year physics
PHY2IMG	Imaging and Materials Characterisation	2	2	15	24	18	A first year unit in physics or chemistry

Year 3							
PHY3ANP	Atomic and Nuclear Physics	1	3	15	24	36	Equivalent of second year physics
PHY3EPP	Electromagnetic Theory and Plasma Physics	2	3	15	24	36	Equivalent of second year physics
PHY3PQM	Physics of Quantum Matter	1	3	15	24	36	Equivalent of second year physics
PHY3TSP	Thermal and Statistical Physics	2	3	15	24	36	Equivalent of second year physics
PHY3NMF	Nanomaterials and Fabrication		3	15	24	36	Equivalent of second year physics
PHY3SPM	Scanning Probe Micropscopies		3	15	24	36	Equivalent of first year physics
PHY3SYN	Synchrotron Science and Technology		3	15	24	36	Equivalent of first year physics
Year 4							
PHY4MES	Mesoscopic Nanoscience	1	4	15	24	36	Equivalent of 3rd year physics with a grade of 65% +
PHY4QME	Quantum Mechanics and Electrodynamics	1	4	15	24	36	Equivalent of 3rd year physics with a grade of 65% +
PHY4SSC	Surface Science	2	4	15	24	36	Equivalent of 3rd year physics with a grade of 65% + or approval of the Nanotechnology Course Cordinator
PHY4XRY	X-ray Science	2	4	15	24	36	Equivalent of 3rd year physics with a grade of 65% + or approval of the Nanotechnology Course Cordinator
PHY4THA	Physics Honours Thesis A	1,2	4	30	-	-	Equivalent of 3rd year physics with a grade of 65% +
PHY4THB	Physics Honours Thesis B	1,2	4	30	-	-	Equivalent of 3rd year physics with a grade of 65% +
PHY4THX	Physics Honours Thesis Extended	1,2	4	60	-	-	Equivalent of 3rd year physics with a grade of 65% +
Year 5							
PHY5DIR	Directed Study in Physics	1,2	5	15	-	-	Equivalent of 3rd year physics with a grade of 65% +
PHY5NFA	Advanced Nanomaterials and Fabrication	2	5	15	24	36	Approval of the Nanotechnology Course Cordinator
PHY5SPA	Advanced Scanning Probe Microscopy	2	5	15	24	36	Approval of the Nanotechnology Course Cordinator
PHY5SYA	Advanced Synchrotron Science and Technology	1	5	15	24	36	Approval of the Nanotechnology Course Cordinator

Study Abroad Opportunities at La Trobe University, Melbourne
Physics and Nanotechnology

Study Abroad Units – Unit Descriptions

Semester 1 – 13 weeks duration, March to June
Semester 2 – 13 weeks duration, July – October
An examination period of 3 weeks follows each semester

Undergraduate and Postgraduate Units in Physics and Nanotechnology

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
Year 1							
PHY1SCA	Principles of Physics A "Physics 100"	1	1	15	36	48	On completion of this unit, students should comprehend a broad range of physics which provides the basis for further study in physics, engineering or another science, should have acquired a basic level of skill in the use of physical laboratory instrumentation and should have developed problem solving skills appropriate to the course material and involving the use of and thermodynamics based methods. Topics covered include mechanics, thermodynamics, waves and optics. The laboratory component consists of a mix of experiments and tutorial-style instruction closely related to the lectures. This unit and the second semester unit PHY1SCB together constitute a mainstream course in Physics at the first-year level. **Pre-requisites:** None, physics or mathematics at high school level preferred
PHY1SCB	Principles of Physics B "Physics 100"	2	1	15	36	48	On completion of this unit, students should comprehend a broad range of physics which provides the basis for further study in physics, engineering or another science, should have acquired a basic level of skill in the use of physical laboratory instrumentation and should have developed problem solving skills appropriate to the course material and involving the use of elementary calculus-based methods. Topics covered include energy, materials and modern physics. The laboratory component consists of a mix of experiments and tutorial-style instruction closely related to the lectures. This unit and the first semester unit PHY1SCA together constitute a mainstream course in Physics at the first-year level **Pre-requisites:** None, physics or mathematics at high school level preferred

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
PHY1LSA Y	Physics for Life Sciences A	1	1	15	36	48	The generation of sufficient energy to meet the massive demands of a modern technological society, without impacting adversely on the environment, is an important issue. While the problems of environmental pollution, resource depletion, greenhouse effect, ozone hole etc, are well known, they are not necessarily well understood. It is important that discussion of these issues be well informed. The physical principles central to the range of conventional and alternative energy technologies is discussed, and on completion, students should understand the advantages and disadvantages of the various technologies and some of the techniques used to monitor and analyse any hazardous effects. This is an introductory course with minimal mathematical content and no specific science background or previous experience of the above topics is assumed. The unit may be taken independently or in conjunction with PHY1LSB. **Pre-requisites:** None
PHY1LSB Y	Physics for Life Sciences B	2	1	15	36	48	This unit is a natural sequel to PHY1LSA, but may be taken independently. Fundamental concepts and techniques in the broad range of topics appropriate for a proper study of the physical environment are introduced. Application of these ideas to systems of biological interest is emphasised. Topics include mechanics, properties of matter, heat and thermodynamics, electric circuits and introductory electronics, atomic physics and radioactivity, fluids and flow, atmospheric physics, light and sound and soil physics. On completion, students should have a basic understanding of measurement techniques as well as familiarity with the fundamental principles in the above topics. No previous study of physics is assumed and mathematical methods are limited to basic algebra. **Pre-requisites:** None
PHY1AST Y	Astronomy and Space: The Infinite Frontier	2	1	15	24	36	This introduction to contemporary astronomy and our developing understanding of the universe is appropriate for students from any background. The single prerequisite is a curiosity as to the nature of our universe and how we go about investigating it. Topics discussed range from our own solar system and the individual planets, through the galaxy to the distant features of the universe, exotic objects such as quasars and black holes, cosmology and the big bang and astronomical instruments. Extensive use is made of multimedia presentations. The practical work includes hands-on sessions and daytime and evening viewing sessions. In computer-based laboratories students simulate the role of practising astronomers and also have the opportunity to explore resources on the internet. **Pre-requisites:** None

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
Year 2							
PHY2EMM	Electromagnetism and Modern Materials	2	2	15	24	48	Modern materials and electromagnetic theory are explored. In the electromagnetic theory component students develop an understanding of the interaction of charges with electric and magnetic fields; the mathematical descriptions of these interactions and their generalisations which lead to Maxwell's equations; and the students' ability to use vectors and differential calculus to describe physical phenomena. In modern materials students develop their understanding of crystalline materials and the physics of conductors and semiconductors including valence and bonding, crystal structures, dislocations, binary phase diagrams, conduction in metals and semiconductors, and semiconductor devices. In the laboratory component an extensive selection of experiments relate to the components. **Pre-requisites:** Equivalent of first year physics
PHY2MOD	Modern Physics	2	2	15	24	48	Two key areas of modern physics, special relativity and quantum mechanics, are explored, supported by a laboratory component. Special relativity considers Einstein's postulates, spacetime diagrams, simultaneity, Lorentz transformations, time dilation and length contraction, relativistic Doppler effect, twin paradox, relativistic momentum and energy, 4-vectors, mass-energy equivalence, causality, and electromagnetism. In quantum mechanics, students develop their understanding of quantisation, wave-particle duality, Schrodinger equation, particle-in-a-box, expectation values and operators, simple harmonic oscillator, reflection and transmissions of waves, stationary and time-dependent states, quantisation of angular momentum and spin. The laboratory component comprises a selection of experiments illustrating some of the key ideas in modern physics. **Pre-requisites:** Equivalent of first year physics
PHY2OPT	Optics	1	2	15	24	48	Geometrical and wave optics and their application to lens and mirror systems, holography, lasers and other modern systems including LCD, CCD, CD and DVD are explored. Students develop understanding of geometric optics and its applications to optical instruments, interference, optical interferometry, coherence of light, Fraunhofer diffraction, diffraction gratings, Fresnel diffraction, matrix treatment of polarization, production of polarized light, holography, Fourier optics, Fresnel equations, lasers, and selected modern applications. The laboratory component comprises a selection of experiments illustrating some of the key ideas in optics. **Pre-requisites:** Equivalent of first year physics
PHY2IMG	Imaging and Materials Characterisation	2	2	15	24	18	Chemical and structural properties of materials using the techniques of optical microscopy, electron microscopy, x-ray diffraction, x-ray fluorescence and image analysis are characterised in this unit. Materials investigated will range from earth assemblages (minerals and soils) to technological materials such as semiconductors and integrated circuits. **Pre-requisites:** A first year unit in physics or chemistry

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
Year 3							
PHY3ANP	Atomic and Nuclear Physics	1	3	15	24	36	Atomic, nuclear, and sub-nuclear structure, radiation physics and nuclear energy are explored. Students enhance their practical and computational skills with a range of laboratory experiments. This unit is one of four such units at 3rd year level that together constitute the physics major stream. This stream is an excellent preparation for a career in the physical sciences and education and for honours and post-graduate research studies in Physics. **Pre-requisites:** Equivalent of second year physics
PHY3EPP	Electromagnetic Theory and Plasma Physics	2	3	15	24	36	Advanced electromagnetic theory and plasma physics are explored. Students enhance their practical and computational skills with a range of laboratory experiments. This unit is one of four such units at 3rd year level that together constitute the physics major stream. This stream is an excellent preparation for a career in the physical sciences and education and for honours and post-graduate research studies in Physics. **Pre-requisites:** Equivalent of second year physics
PHY3PQM	Physics of Quantum Matter	1	3	15	24	36	Fundamental quantum physics and its application to understanding the electronic and thermal properties of matter are explored. Students enhance their practical and computational skills with a range of laboratory experiments. This unit is one of four such units at 3rd year level that together constitute the physics major stream. This stream is an excellent preparation for a career in the physical sciences and education and for honours and post-graduate research studies in Physics. **Pre-requisites:** Equivalent of second year physics
PHY3TSP	Thermal and Statistical Physics	2	3	15	24	36	The thermal physics of matter, from a classical thermodynamic and statistical perspective is explored, with applications from a diverse range of fields including materials science, biophysics, cold-atom physics and quantum fluids. Students enhance their practical and computational skills with a range of laboratory experiments. This unit is one of four such units at 3rd year level that together constitute the physics major stream. This stream is an excellent preparation for a career in the physical sciences and education and for honours and post-graduate research studies in Physics. **Pre-requisites:** Equivalent of second year physics
PHY3NMF	Nanomaterials and Fabrication		3	15	24	36	In this unit, students will study many aspects of the structure and function of nanomaterials and small scale devices, together with contemporary fabrication techniques. Unit themes include: (a) nanomaterials synthesis and applications, carbon nanotubes, and nanowires, (b) quantum effects in nanostructured materials, layered semiconductors and devices, (c) nanostructured interfaces and small scale devices, examining the "top-down" approach to fabrication, (d) introductory concepts in microfabrication, (e) MEMS and NEMS, (f) advanced lithographic techniques including photolithography, electron beam lithography, interference lithography, micro-contact printing and nano imprint lithography. **Pre-requisites:** Equivalent of second year physics

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
PHY3SPM	Scanning Probe Micropscopies		3	15	24	36	In this unit, students will study the principle of operation of scanning probe microscopes (SPMs), in particular, scanning tunnelling microscopy (STM) and atomic force microscopy (AFM), and the instrumentation and probes required to implement these techniques. Non-contact AFM, low temperature SPM, dynamic force microscopy and molecular recognition force microscopy will also be considered. Students will be introduced to the concepts and practice of nanolithography and electrochemical SPM. **Pre-requisites:** Equivalent of first year physics
PHY3SYN	Synchrotron Science and Technology		3	15	24	36	In this unit, students will study the design, underlying physical principles, operation and applications of modern synchrotron light sources. Specifically, this unit will include an introduction to accelerator physics and the production of synchrotron light, discussion of electron generation, booster and storage ring systems found in modern synchrotron facilities, and the design and function of insertion devices, monochromators and beam lines. A wide range of synchrotron-based experimental techniques and their applications will be explored including spectroscopy, microscopy and imaging techniques, diffraction, crystallography, lithography and fabrication. **Pre-requisites:** Equivalent of first year physics
Year 4							
PHY4MES	Mesoscopic Nanoscience	1	4	15	24	36	Topics beyond the concepts traditionally taught in condensed matter physics are considered, in particular, modern electronic systems that have arisen primarily through an ability to construct devices on nanometer length-scales and in reduced dimensions. The course examines semiconductor materials and doping, bandstructure engineering, quantum confinement and electronic transport in wells, wires and dots, quantized conductance and the quantum Hall effect. The electronic properties of emerging carbon materials, such as carbon nanotubes, diamond and graphene, and of metallic systems engineered on the atomic scale via molecular manipulation are examined. Attention then turns to the mesoscopic properties of superconducting systems, examining the Josephson effects, flux quantization, SQUIDs and superconducting nanowires. Much of the material taught underlies emerging quantum technologies, with application to metrology, sensor development and quantum information. **Pre-requisites:** Equivalent of 3^{rd} year physics with a grade of 65% +
PHY4QME	Quantum Mechanics and Electrodynamics	1	4	15	24	36	The course provides a solid theoretical background in quantum mechanics and electrodynamics coupled with practical examples. The topics in quantum mechanics include matrix mechanics formalism, perturbation theory, variational method and virial theorem, and relativistic quantum mechanics. The topics in electrodynamics include potential formulation of electrodynamics, electromagnetic radiation, relativistic electrodynamics, and electromagnetic waves. **Pre-requisites:** Equivalent of 3^{rd} year physics with a grade of 65% +

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
PHY4SSC	Surface Science	2	4	15	24	36	Characterisation of solid material surfaces and surface layers, preparation of clean solid surfaces for analysis, thermal treatment, ion etching, adsorption, description and adsorption isotherm models (Langmuir et al.) surface structural techniques, LEED (Low Energy Electron Diffraction), STM (Scanning Tunnelling Microscopy), AFM (Atom Force Microscopy), EXAFS (Extended X-ray Absorption Fine Structure), surface analytical techniques, XPS (X-ray Photoelectron Spectroscopy), SIMS (Secondary Ion Mass Spectrometry), AES (Auger Electron Spectroscopy), NEXAFS (Near Edge), SEXAFS (Surface), atomic electron binding energies in materials and surfaces, Hartree-Fock methods of calculation of core level binding energy of electrons, laboratory and synchrotron photon sources for performing surface analysis, introductory XPS techniques, spectral analysis in XPS including multiplet splitting, shake-up-off, angle resolved effects and photoelectron diffraction. **Pre-requisites:** Equivalent of 3rd year physics with a grade of 65% + or approval of the Nanotechnology Course Cordinator
PHY4XRY	X-ray Science	2	4	15	24	36	The optics and applications of x-rays are introduced. Emphasis is placed on imaging and synchrotron-source related applications. The major topics covered include: Diffraction of x-rays in free space; Partially coherent fields; Interactions of x-rays with matter; X-ray sources; X-ray optics; and Synchrotron based applications of x-rays. In particular, the production of x-rays and the properties of x-ray light from a synchrotron source are examined. In addition the principal of operation and some of the practical issues relating to the optical manipulation of x-rays using diffractive, refractive and reflective optics are discussed. The course makes use of the Australian Synchrotron as an example and, scheduling permitting, will involve a visit to it and interaction with beamline staff. **Pre-requisites:** Equivalent of 3rd year physics with a grade of 65% + or approval of the Nanotechnology Course Cordinator
PHY4THA	Physics Honours Thesis A	1,2	4	30	-	-	This unit is the first part of a 60CP thesis program (PHY4THA and PHY4THB). Students will not be given a final mark until they complete PHY4THB. Students commence a project that takes the equivalent of six months of continuous work under the supervision of a member of staff. The project is completed and written up as a thesis when the student completes the unit PHY4THB. All students are required to present a seminar outlining the proposed project at a time to be determined by the physics honours coordinator. A list of prospective thesis topics and supervisors is available from the Department of Physics postgraduate co-ordinator. **Pre-requisites:** Equivalent of 3rd year physics with a grade of 65% +

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
PHY4THB	Physics Honours Thesis B	1,2	4	30	-	-	This unit is the second part of a 60CP thesis program (PHY4THA and PHY4THB). Students will not be given a final mark until they complete PHY4THB. Students complete a project that takes the equivalent of six months of continuous work under the supervision of a member of staff. The project is completed and written up as a thesis when the student completes the unit PHY4THB. All students are required to present a seminar outlining the proposed project at a time to be determined by the physics honours coordinator. A list of prospective thesis topics and supervisors is available from the Department of Physics postgraduate co-ordinator. **Pre-requisites:** Equivalent of 3^{rd} year physics with a grade of 65% +
PHY4THX	Physics Honours Thesis Extended	1,2	4	60	-	-	This unit is a 60CP thesis program completed in one semester. It is recommended that students complete the honours thesis requirement over two semesters by enrolling in PHY4THA and PHY4THB. In special circumstances, for eg., international exchange students and students with an irregular course plan, enrolment may be permitted in PHY4THX and honours thesis requirements completed in one semester. Students complete a project that takes the equivalent of six months of continuous work under the supervision of a member of staff. The project is completed and written up as a thesis. All students are required to present a seminar outlining the proposed project at a time to be determined by the physics honours coordinator. A list of prospective thesis topics and supervisors is available from the Department of Physics postgraduate co-ordinator. It is strongly recommended that students who wish to complete the requirements of the thesis in one semester should commence preliminary reading for the project no later than the end of the prior semester. **Pre-requisites:** Equivalent of 3^{rd} year physics with a grade of 65% +
Year 5							
PHY5DIR	Directed Study in Physics	1,2	5	15	-	-	Students carry out independent study in one of the areas of research activity of the Department of Physics, supervised by a member of staff. A list of prospective study topics and supervisors is available from the Department of Physics postgraduate co-ordinator. **Pre-requisites:** Equivalent of 3^{rd} year physics with a grade of 65% +
PHY5NFA	Advanced Nanomaterials and Fabrication	2	5	15	24	36	In this unit, students will study many aspects of the structure and function of nanomaterials and small scale devices at an advanced level, together with contemporary fabrication techniques. Unit themes include: (a) nanomaterials synthesis and applications, carbon nanotubes, and nanowires, (b) quantum effects in nanostructured materials, layered semiconductors and devices, (c) nanostructured interfaces and small scale devices, examining the "top-down" approach to fabrication, (d) introductory concepts in microfabrication, (e) MEMS and NEMS, (f) advanced lithographic techniques including photolithography, electron beam lithography, interference lithography, micro-contact printing and nano imprint lithography. **Pre-requisites:** Approval of the Nanotechnology Course Cordinator

Unit Code	Unit Title	Sem.	Year Level	LTU CPs	Lecture Hours	Lab/Tutorial Hours	Unit Description
PHY5SPA	Advanced Scanning Probe Microscopy	2	5	15	24	36	In this unit, students will study the principle of operation of scanning probe microscopes (SPMs), in particular, scanning tunnelling microscopy (STM) and atomic force microscopy (AFM), and the instrumentation and probes required to implement these techniques at an advanced level. Non-contact AFM, low temperature SPM, dynamic force microscopy and molecular recognition force microscopy will also be considered. Students will be introduced to the concepts and practice of nanolithography and electrochemical SPM. **Pre-requisites:** Approval of the Nanotechnology Course Cordinator
PHY5SYA	Advanced Synchrotron Science and Technology	1	5	15	24	36	In this unit, students will study the design, underlying physical principles, operation and applications of modern synchrotron light sources at an advanced level. This unit includes an introduction to accelerator physics and the production of synchrotron light, discussion of electron generation, booster and storage ring systems found in modern synchrotron facilities, and the design and function of insertion devices, monochromators and beam lines. A wide range of synchrotron-based experimental techniques and their applications will be explored including spectroscopy, microscopy and imaging techniques, diffraction, crystallography, lithography and fabrication. **Pre-requisites:** Approval of the Nanotechnology Course Cordinator