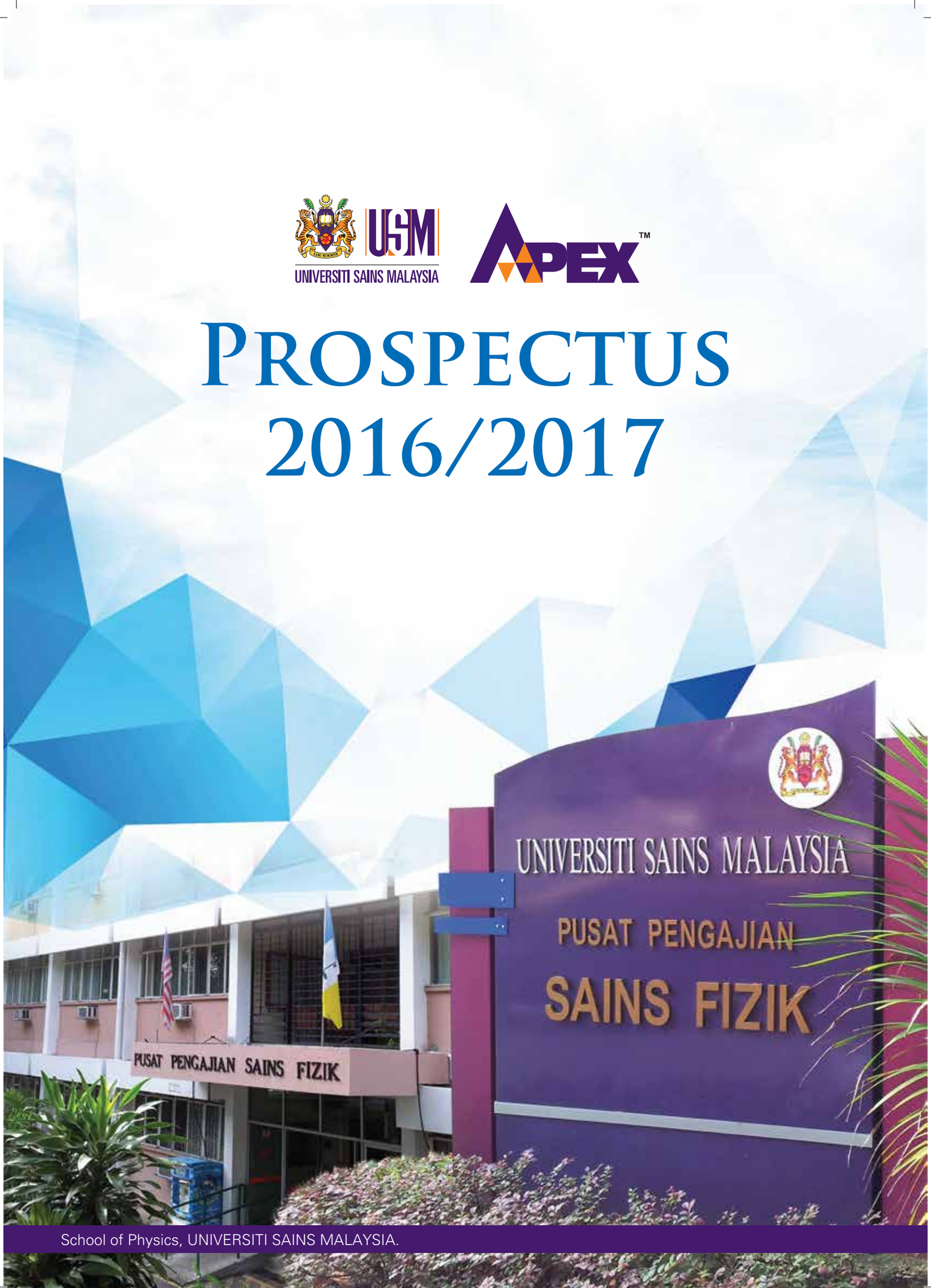
UNIVERSITI SAINS MALAYSIA

PROSPECTUS 2016/2017



School of Physics, UNIVERSITI SAINS MALAYSIA.

Introduction

The School of Physics was established in 1969 at the MTC (RECSAM) building where USM was initially located. When USM moved its location to Minden in 1971, the School of Physics was transferred to the new campus grounds and had been sited at the G06 building. With the growing needs for education and research, the School of Physics occupies building G05 and G06A as its teaching and administration building. The School of Physics had developed under several prominent Deans and had continued in its excellence under the present administration of Professor Dr. Haslan Abu Hassan. Ever since it was first established, the School of Physics had offered several academic programmes. At present there are five undergraduate programmes namely, Pure Physics, Applied Physics, Geophysics, Medical Physics and Engineering Physics. The higher degree programmes at the School of Physics commenced in 1972 and is well established to help meet the growing needs of physicists in various fields in the era of high technology and knowledge – based society.

Currently four postgraduate programmes are being offered namely, Master of Science degree by coursework that is M.Sc. (Solid State Physics) and M.Sc (Medical Physics), Master of Science degree by mixed mode that is M.Sc. (Applied Geophysics) and M.Sc. (Radiation Science) and M.Sc. and Ph.D by Research programmes. At par with the development of USM as APEX University, the School of Physics has developed its research activities. The academic staff have excelled in their research fields and innovation reaping numerous awards at national and international levels in the related disciplines.

Well known for X-ray Crystallography and Nano-Optoelectronics research activities, which are actively involved in national and international collaborations, the School of Physics has also been very actively taking advantage of the interest in energy research nowadays to become the main contributor in the area and to make energy another School's niche area of research. Even though maintaining the competitiveness of the niche areas in the School of Physics and thrusting of potential researches to become one of the School's niches is the utmost priority, other research activities are also well facilitated to maintain the good track record of the School in research. The research activities in the School are strongly supported by the Geophysics, Medical Physics and Radiation Science, Solid and Theoretical Physics research groups in order for the School of Physics to become the driving force in the University's research.

The research and education development of the School of Physics have been further strengthened with the set up of its 'excellent centres' that is CETREE (Centre for Education, Training and Research in Renewable Energy and Energy Efficiency) and AASRU (Astronomy and Atmospheric Science Research Unit). Apart from the research in their respective areas, these centres are also responsible for education and awareness programmes to the public.

Currently the School of Physics has links with the Malaysian Nuclear Agency (Nuklear Malaysia), Atomic Energy Licensing Board (AELB) and International Atomic Energy Agency (IAEA) which runs a programme that is the IAEA Postgraduate Educational Course in Radiation Protection and the Safety of Radioactive Sources for the IAEA member states from the Asia Region. At present, with its world class facilities and excellent staff, the School of Physics will continue to pave its way to greater heights in providing quality education and research.

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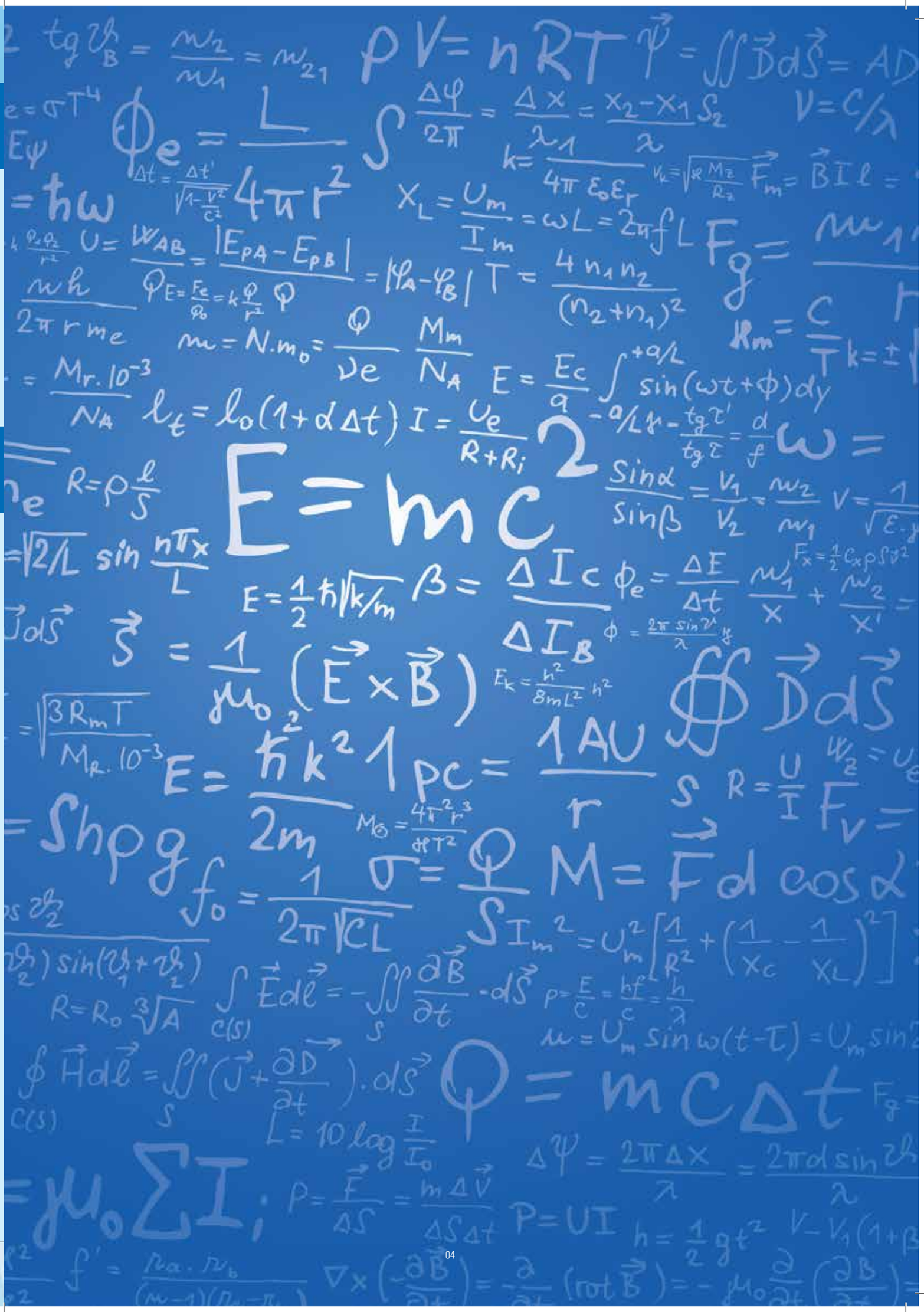
E=mc

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POSTGRADUATE STUDY

Master of Science - Coursework
- Medical Physics
- Solid State Physics

Master of Science - Mixed Mode
- Applied Geophysics
- Radiation Science
- International Master Parallel Programme [(Master of Engineering in Electrical and Microsystems Engineering) and (Master of Science in Solid State Physics)]
- MSc (Radiation Science) Off-shore

Master of Science and Doctor of Philosophy - Research

Research Areas:
- Applied and Engineering Physics
- Condensed Matter Physics and X-ray Crystallography
- Energy Studies
- Geophysics, Astronomy and Atmospheric Science
- Medical Physics and Radiation Science
- The oretical and Computational Physics

Admission Requirements

Applicants should possess one of the following:

Master of Science (MSc) - Mixed Mode and Coursework
- A Bachelor's degree in Physics minimum CGPA 3.00 (Max: 4.00) or equivalent.
- A Bachelor's degree in a related area.
- International applicants are required to have a minimum score of 550 (Paper-based) in TOEFL (Test of English as a Foreign Language) or a minimum score of 213 (Computer-based) in TOEFL (Test of English as a Foreign Language) or a minimum score of 80 (Internet-based) in TOEFL (Test of English as a Foreign Language) or minimum score of 6.0 in IELTS (International English Language Testing System). Results must be attached with the application form.

Master of Science (MSc) - Research
- A Bachelor's degree in Physics minimum CGPA 2.75 (Max: 4.00) or equivalent.
- A Bachelor's degree in a related area.
- International applicants are required to have a minimum score of 550 (Paper-based) in TOEFL (Test of English as a Foreign Language) or a minimum score of 213 (Computer-based) in TOEFL (Test of English as a Foreign Language) or a minimum score of 80 (Internet-based) in TOEFL (Test of English as a Foreign Language) or minimum score of 6.0 in IELTS (International English Language Testing System). Results must be attached with the application form.

Doctor of Philosophy (PhD) - Research
- A Master's or Bachelor's [First Class Honours or CGPA >3.67 (Max: 4.00)] degree in a related area.
- International applicants are required to have a minimum score of 550 (Paper-based) in TOEFL (Test of English as a Foreign Language) or a minimum score of 213 (Computer-based) in TOEFL (Test of English as a Foreign Language) or a minimum score of 80 (Internet-based) in TOEFL (Test of English as a Foreign Language) or minimum score of 6.0 in IELTS (International English Language Testing System). Results must be attached with the application form.

Duration

Master of Science - Mixed Mode and Coursework
(Medical Physics, Solid State Physics, Applied Geophysics and Radiation Science)
Full-time : Min 2 semesters / Max 4 semesters

Master of Science - Mixed Mod
{International Master Parallel Programme [(Master of Engineering in Electrical and Microsystems Engineering) and (Master of Science in Solid State Physics)]}
Full-time : Min 4 semesters / Max 10 semesters

Master of Science (MSc) - Research
Full-time : Min 2 semesters / Max 6 semesters
Part-time : Min 4 semesters / Max 12 semesters

Doctor of Philosophy (PhD) - Research
Full-time : Min 4 semesters / Max 10 semesters
Part-time : Min 6 semesters / Max 15 semesters

Facilities

The School of Physics houses many scientific facilities and laboratories to support the ongoing teaching and research activities. Some of which are:

- First and Second Year Teaching laboratories
- Computer and CAI laboratories
- Microprocessor laboratory
- Engineering Physics laboratory
- Workshop for Engineering Physics
- Medical Physics laboratory
- Radiation Biophysics laboratory
- X-Ray Crystallography laboratory
- Geophysics laboratory
- Solid State laboratory
- Energy laboratory
- Theoretical Physics laboratory
- Institude of Nano-Optoelectronics Research and Technology (INOR) - shared facilities

The new Student Center at the School of Physics is a one-stop center with facilities for students to conduct various activities.

Research Group Leader

1. APPLIED AND ENGINEERING PHYSICS
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2. CONDENSED MATTER PHYSICS AND X-RAY CRYSTALLOGRAPHY
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4. GEOPHYSICS, ASTRONOMY AND ATMOSPHERIC SCIENCE
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5. MEDICAL PHYSICS AND RADIATION SCIENCE
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How to apply

Apply directly via online through USM
website: http://onlineips.usm.my/admission/

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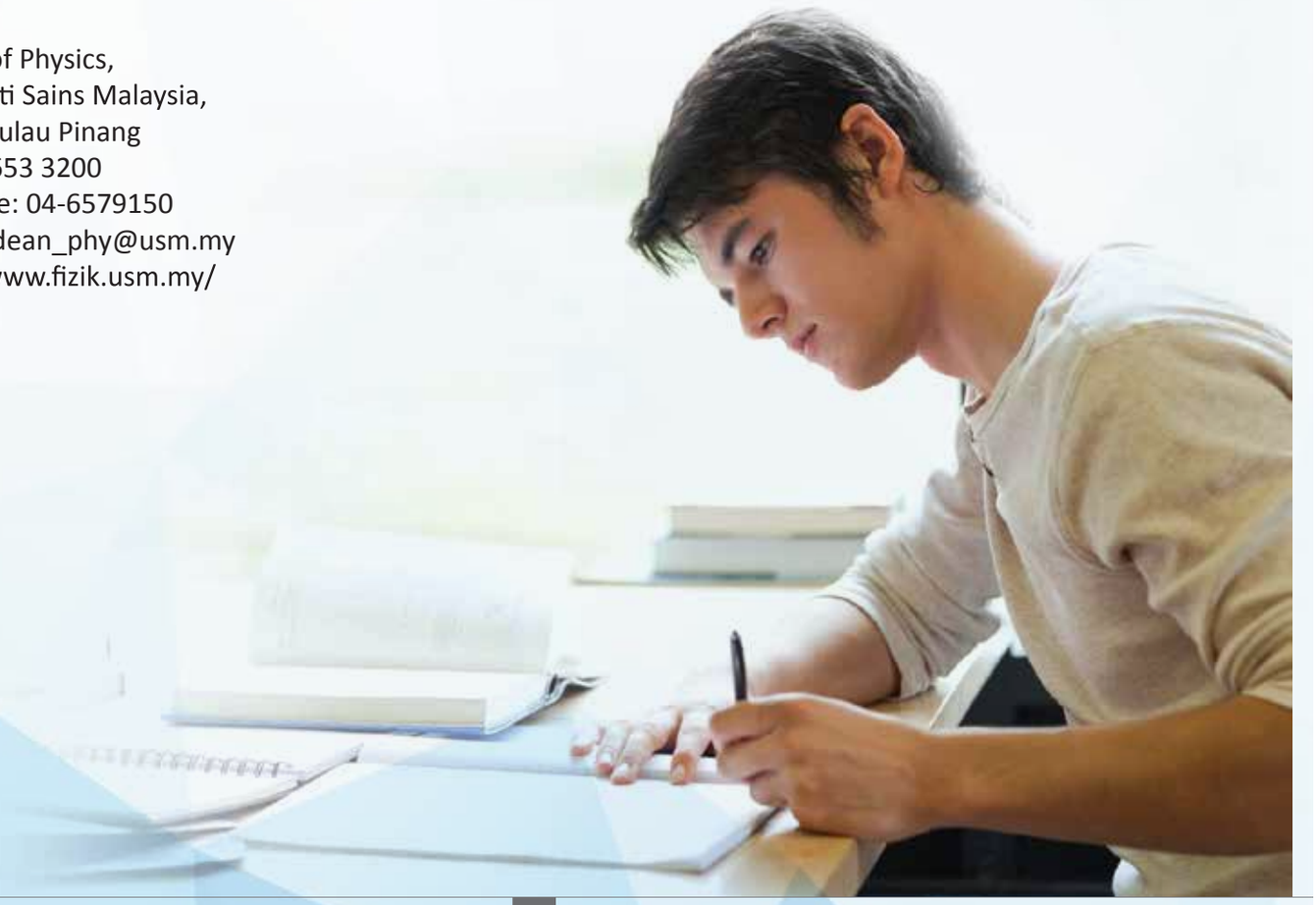


INTERNATIONAL STUDY PROGRAM

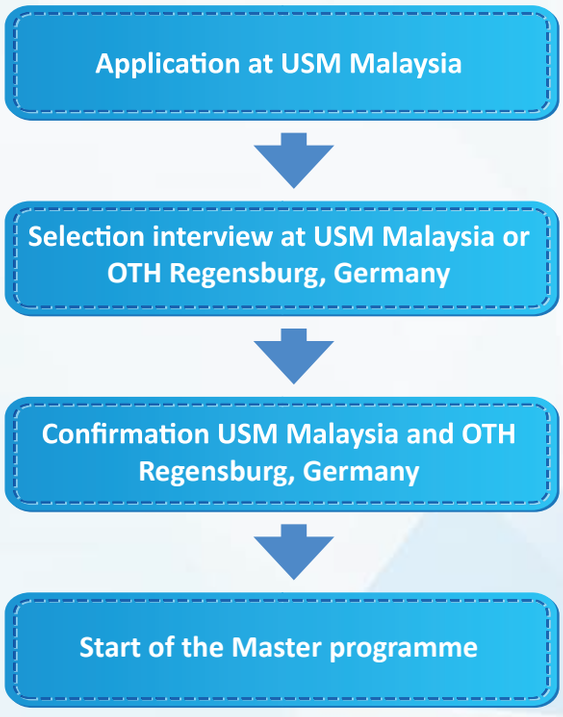
International Dual Degree Programme [(Master of Engineering in Electrical and Microsystems Engineering) and (Master of Science in Solid State Physics)]

Our new Master degree programme places a strong focus on electronics and semiconductor technology. It provides a solid theoretical background as well as a minimum of 6 months internship in one of our international partner companies (e.g. Osram, Infineon Technologies, Continental Automotive Corporation) in Malaysia or Germany. Besides the classic master programme there is the possibility of a dual degree. This dual degree programme offers you the opportunity to obtain a Master degree from Malaysia (USM Penang) in combination with an accredited European Master degree (M. Eng in Electrical and Microsystems Engineering) from OTH Regensburg (Germany) simultaneously. The course is structured to enable students to work independently, efficiently and responsibly using scientific methods and problem-solving techniques. Aside from conveying technical expertise, the course is designed to build personalities and leadership knowledge and skills. Graduates will be equally proficient in performing technical tasks and leadership roles.

Lectures in Malaysia or Germany:
Min. 24 months (min. of 12 months in Germany) / Max 8 semesters

Master thesis in Malaysia or Germany (usually in a company):
Min. 6 months

APPLICATION PROCESS



DEGREE PROGRAMME

SM and OTH (for USM Students)	
Master of Science (Solid State Physics)	Master of Engineering (Electrical and Microsystems Engineering)

WS* USM Sep-Jan	USM	OTH
Solid State Physics Theory (ZCC 541/4)	core (4CH)	
Physics of Complementary Materials (ZCC 542/4)	core (4CH)	Elective (5CP)
Semiconductor Physics (ZCC 543/4)	core (4CH)	Elective (5CP)
X-ray Structure (ZSC 548/4)	core (4CH)	Elective (5CP)
Measurements & Experimental Techniques I (ZCC 591/4)	core (4CH)	core int. (5CP)
Total (CH/CP)	20 CH	20 CP

SS* OTH Mar-Aug	USM	OTH
Mathematics for Master		core (8CP)
Technical Optics – Micro-optics (TOM)		core (5CP)
Elective Subject **		Elective ** (5CP)
Project Thesis		6CP
Total (CH/CP)		24 CP

WS* OTH Oct-Feb	USM	OTH
Optoelectronics		core (8CP)
Laser Technology and Photonics		core (5CP)
Elective Subject **		Elective **
German Language		core int. (7CP)
Total (CH/CP)		20 CP

MT MAL or GER Mar-Aug (6m)	USM	OTH
Master Thesis	dissertation (20CH)	thesis (26CP)
Total (CH/CP)	20 CH	26 CP

USM and OTH (for OTH Students)	
Master of Science (Solid State Physics)	Master of Engineering (Electrical and Microsystems Engineering)

SS* OTH Mar-Aug	USM	OTH
Mathematics for Master		core (8CP)
Technical Optics - Microoptics (TOM)		core (5CP)
Elective Subject **		Elective ** (5CP)
Project Thesis		6CP
English Language		core int. (7CP)
Total (CH/CP)		31 CP

WS* USM Sept-Jan	USM	OTH
Solid State Physics Theory (ZCC 541/4)	core (4CH)	
Physics of Complementary Materials (ZCC 542/4)	core (4CH)	Elective (5CP)
Semiconductor Physics (ZCC 543/4)	core (4CH)	Elective (5CP)
X-ray Structure (ZSC 548/4)	core (4CH)	Elective (5CP)
Measurements & Experimental Techniques I (ZCC 591/4)	core (4CH)	core int. (5CP)
Total (CH/CP)	20 CH	20 CP

SS* USM Feb-Jun	USM	OTH
Physics of Optic Communication (ZSC 549/4)	Elective (4CH)	core (4CP)
Semiconductor Devices (ZSC 546/4)	Elective (4CH)	core (4CP)
Measurements & Experimental Techniques II (ZCC 592/4)	core (4CH)	core (5CP)
Malay Language	core (2CH)	
Total (CH/CP)	14 CH	13 CP

MT MAL or GER Jul-Dec (6m)	USM	OTH
Master Thesis	dissertation (20CH)	thesis (26CP)
Total (CH/CP)	20 CH	26 CP

* WS – Winter semester
* SS – Summer semester

**Chose one Elective Subject (in WS or SS)
SS: Electronic Product Engineering or
Master Optoelectronic Projects in Labview
WS: Laser Materials Processing or Cybernetics

DEGREE PROGRAMME – MSc (Medical Physics)

The MSc in Medical Physics is a one year coursework program designed to provide pathway into a career in medical physics. Applicants must hold an undergraduate degree in Medical Physics or Physics. Admission is also considered for graduates in other relevant disciplines with adequate knowledge of Physics, Medical Physics and Radiation Physics.

Program Structure

The program comprises of coursework courses, practical followed by a research project. The syllabus encompasses topics on ionizing and non-ionizing radiation related to medical physics field.

Semester 1	Semester 2	Short Semester KSCP
1. Anatomy and Physiology (ZCT 531/4)	1. Radiotherapy and Nuclear Medicine (ZCT 535/4)	1. Project (ZCT 595/8)
2. Radiation Physics (ZCT 532/4)	2. Ultrasound and Magnetic Resonance Imaging (ZCE 537/2)	
3. Dosimetry and Radiation Protection (ZCT 533/4)	3. Radiobiology and Radiation Chemistry (ZCE 538/2)	
4. Physics Diagnostic Radiology (ZCT 534/4)	4. 4.Project (ZCT 595/8)	
5. Medical Physics Practical I (ZCT 596/4)	5. Medical Physics Practical II (ZCT 597/4)	

** KSCP = Short Semester Courses During the Long Vacation (Kursus Semasa Cuti Panjang)*

Teaching and Assessment

Teaching and learning are delivered through lectures, seminars, and laboratory sessions. Assessments include both written and oral examinations including together with group/individual projects and report writing for practical laboratory sessions. The practical component allows students to develop hands-on experience in carrying out laboratory experiments related to medical imaging modalities and radiation detectors and other radiation related instrumentations. Each student is required to undertake a research project in Semester II that leads to a report writing in Short Semester KSCP. Research projects are offered by variety of research groups structured to develop skills and to provide extensive knowledge in Radiotherapy, Nuclear Medicine, Radiology or Non-Ionising radiation for medical related purposes.

DEGREE PROGRAMME – MSc (Solid State Physics)

The MSc in Solid State Physics is a one year coursework program designed to provide pathway into a career in the area of semiconductor technology. Applicants must hold an undergraduate degree in Physics and Applied Physics. Admission is also considered for graduates in other relevant disciplines with adequate knowledge of Physics and Applied Physics.

Program Structure

The program comprises of coursework courses, practical followed by a research project. Courses offered in this program include:

Semester 1	Semester 2	Short Semester KSCP
1. Solid State Physics Theory (ZCC 541/4)	1. Semiconductor Devices (ZSC 546/4)	1. Project (ZCC 593/8)
2. Physics of Complementary Materials (ZCC 542/4)	2. Physics of Optic Communication (ZSC 549/4)	
3. Semiconductor Physics (ZCC 543/4)	3. Measurements & Experimental Techniques II (ZCC 592/4)	
4. X-ray Structure (ZSC 548/4)	4. Project (ZCC 593/8)	
5. Measurements & Experimental Techniques I (ZCC 591/4)		

** KSCP = Short Semester Courses During the Long Vacation (Kursus Semasa Cuti Panjang)*

Teaching and Assessment

Teaching and learning are delivered through lectures, seminars, and laboratory sessions. Assessments include both written and oral examinations including together with group/individual projects and report writing for practical laboratory sessions. The practical component allows students to develop hands-on experience in carrying out laboratory experiments related to semiconductor technology. Each student is required to undertake a research project in Semester II that leads to a report writing in Short Semester KSCP. Research projects are offered by variety of research groups structured to develop skills and to provide extensive knowledge in Solid State Physics.

DEGREE PROGRAMME – MSc (Applied Geophysics)

The Master of Science in Applied Geophysics is a one year mixed mode program that comprises of two components; coursework and research. The program is designed to advance students' knowledge, understanding and hands-on experience to fulfil the career requirements in the field of geosciences or related scientific disciplines.

Applicants must hold an undergraduate degree in Geology or Geophysics. Admission is also considered for graduates in other relevant disciplines with adequate knowledge of geoscience or related subject area.

Program Structure

The program comprises of coursework courses, practical followed by a project that leads to dissertation writing. Courses offered in this program include:

Semester 1	Semester 2	Short Semester KSCP
1. Potential Field Exploration Methods (ZGT 561/4)	1. Dissertation (ZGT 594/20)	1. Dissertation (ZGT 594/20)
2. Seismic Interpretation (ZGT 562/4)		
3. Formation Evaluation (ZGT 563/4)		
4. Remote Sensing Applications (ZGT 564/4)		
5. Engineering Geoscience (ZGE 571/2)		
6. Petroleum Geoscience (ZGE 572/2)		
7. Geoenvironmental Issues (ZGE 573/2)		

** KSCP = Short Semester Courses During the Long Vacation (Kursus Semasa Cuti Panjang)*

Teaching and Assessment

Teaching and learning are delivered through lecturers, seminars, workshops and laboratory sessions. Assessments include both written and oral examinations together with group/individual projects and individual dissertations. The practical component allows students to develop hands-on experience in carrying out laboratory experiments using geophysical instrumentations that will include work both field and laboratory work. Each student is required to undertake a research project in Semester II that leads to a dissertation writing in Short Semester KSCP. Research projects propose specific aims to develop skills and to provide extensive knowledge in Applied Geophysics and Geoscience.

DEGREE PROGRAMME – MSc (Radiation Science)

The Master of Science in Radiation Science is a one year mixed mode program that comprises of two components; coursework and research. The program is delivered in both on-campus and off-shore. The program is designed to advance students' knowledge, understanding and hands-on experience to fulfil the career requirements in the field of Radiation Science and Radiation Protection.

Applicants must hold an undergraduate degree in Radiation Science or Physics. Admission is also considered for graduates in other relevant disciplines with adequate knowledge of Physics, Nuclear Physics and Radiation Physics.

Program Structure

The program comprises of coursework courses, practical followed by a project that leads to dissertation writing. Courses offered in this program include:

Semester 1	Semester 2	Short Semester KSCP
1. Radiation Physics (ZCT 532/4)	1. Dissertation (ZCT 598/20)	1. Dissertation (ZCT 598/20)
2. Dosimetry And Radiation Protection (ZCT533/4)		
3. Radiation Protection I (ZCT551/4)		
4. Radiation Protection II (ZCT552/4)		
5. Practical (ZCT 599/4)		

** KSCP = Short Semester Courses During the Long Vacation (Kursus Semasa Cuti Panjang)*

Teaching and Assessment

Teaching and learning are delivered through lecturers, seminars, workshops and laboratory sessions. Assessments include both written and oral examinations together with group/individual projects and report writing for practical laboratory sessions. The practical component allows students to develop hands-on experience in carrying out laboratory experiments using radiation detectors and radiation related instrumentations. Each student is required to undertake a research project in Semester II that leads to a dissertation writing in Short Semester KSCP. Research projects propose specific aims to develop skills and to provide extensive knowledge in Radiation Science, Radiation Technology and Radiation Protection.

MASTER OF SCIENCE (APPLIED GEOPHYSICS) SYNOPSIS OF COURSES

ZGT 561/4 Potential Field Exploration Methods

Overview of potential field and electrical/electromagnetic exploration methods. Introduction to data inversion methods. Least-squares optimisation method. Ridge regression and smoothness-constrained optimisation methods. L1 and L2 inversion norms. Electrical and electromagnetic methods. Electrical properties of rocks and minerals. Ohm's law and Maxwell's equations. 2D and 3D resistivity and IP surveys-forward modelling with the finite-difference method, field survey methods, data processing and modelling. Electromagnetic methods-passive and active source methods. Magnetotelluric, VLF, frequency-domain and time-domain methods with artificial power sources. Surveys and data interpretation with electromagnetic conductivity systems.

Ground penetrating radar - propagation of radio waves, resolution, field equipment, data acquisition methods, data processing and interpretation. Gravity and magnetic methods - potential field theory, survey methods, data processing and computer modelling. Gravity and magnetic modelling methods for 2D and 3D structures.

ZGT 562/4 Seismic Interpretation

This course is divided into four sections. Section one will discuss the role of geophysics in hydrocarbon exploration. This leads to a discussion of the theoretical background of seismic exploration and basic techniques for data acquisition and processing. Section two will discuss the connection between geology and seismic sections, including vertical seismic profiling (VSP) and well-to-seismic ties. Interpretation techniques such as seismic and geological interpretation, seismic stratigraphy and 3D seismic interpretation will be discussed in section three. AVO analysis will also be covered in this section. Section four consists of a case study and practical component.

(Students enrolling for this course are expected to have sound knowledge of the basics of geology as well as the seismic reflection surveying method.)

ZGT 563/4 Formation Evaluation

Well logging principles, techniques and applications:
Electrical logs, radioactivity logs, sonic/acoustic logs, porosity logs, dipmeter log, qualitative and quantitative interpretation of well logs.

Subsurface mapping:
Geological cross-sections, subsurface geological maps, isopach maps and calculation of reserves.

Subsurface facies analysis:
Sedimentary environments, facies and models; methods of environmental interpretation; summary of depositional sedimentary environments.

Petrography and petrophysics:
Petrographic and petrophysical techniques, petrographic analysis of sedimentary rocks and petrophysical measurements.

ZGT 564/4 Remote Sensing Applications

Remote sensing principles:
Remote sensing in the visible, infrared (near, middle and thermal) and microwave (radar) regions. Airborne and space-borne platforms and sensors. Lidar. Multispectral and hyperspectral data.

Digital image processing of remotely sensed images:
Image preprocessing - geometric and radiometric corrections. Filtering. Fourier analysis. Multispectral transformations – principal components, vegetation indices, texture transformations. Image classification. Change detection analysis.

Selected applications:
Geologic applications – geological mapping, stratigraphy and structure, mineral and petroleum exploration. Hydrologic applications – drought, flooding, groundwater. Oceanographic applications – water quality, bathymetry, sea surface temperature, current, El Nino. Meteorological applications – weather, cloud, rainfall, hurricane etc. Other environmental applications.

ZGE 571/2 Engineering Geoscience

Geophysical techniques used in petroleum and mineral exploration, engineering investigations, environmental and hydrogeological studies and geological mapping. Seismic reflection and refraction methods. Gravity and magnetic methods. Resistivity, induced polarization and self-potential techniques. For each method data acquisition, processing and interpretation will be discussed. Applications and case histories.

ZGE 572/2 Petroleum Geoscience

Introduction to geology - minerals, rocks, rock cycle, fossils, geologic time scale, plate tectonics and earth evolution. Weathering and soils - mechanical and chemical weathering, weathering profile, soil development and soil classification. Sediments, sedimentary rocks and depositional environments. Structural geology - tectonic forces, strike and dip, folds, fractures and faults. Earth resources – minerals, groundwater and hydrocarbon. Field mapping technique.

ZGE 573/2 Geoenvironmental Issues

Fundamentals of soil mechanics. Soil formation, description, classification and sampling. Engineering properties of soils – grain size, density, porosity, permeability, water saturation, plasticity, Atterberg limits, cohesion, compaction, strength, standard penetration test and cone penetration test. Borehole sampling.

Fundamentals of rock mechanics. Effects of weathering and discontinuities on rocks. Engineering properties of rocks – density, porosity, permeability, water saturation, elasticity, strength, rippability, compression tests and shear tests. Rocks as construction materials.

Stability of slopes. Landslides – types, causes, processes and effects of mass movements. Investigation and evaluation of landslides. Basic principles and techniques of stability analysis. Subsidence and settlement. Case histories.

MSc. (MEDICAL PHYSICS)

ZCT 531/4 Anatomy & Physiology

This course provides an introduction on structures and functions of the human body. The syllabus emphasizes on homeostatic mechanisms, chemical, metabolic, and physical principles, in relationship to the organization, growth, development, metabolism and health of the normal individual. Other topics include; focus on neural and endocrine regulation; the cardiovascular system; respiratory; digestive; urinary and reproductive systems.

ZCT 532/4 Radiation Physics

This course introduces students to the atom structure and the origin of radiation. Explain different ways of radiation interaction with matter. Relate the radiation transport behaviour in matter to the attenuation coefficients of each material and radiation energy. Describe different ways of particle accelerators. Explain the methods of radiation detection systems for different types and energies of radiation. The course includes also the production of radioactive isotopes by neutron activation.

ZCT 533/4 Dosimetry And Radiation Protection

This course provides an introduction on operation principles of radiotherapy treatment units, radionuclide labeling techniques and gamma ray imaging. The course emphasizes on dose distribution in tissue produced by external photon beams treatment and dose modification techniques with photon beams; treatment planning and dose delivery electron beam therapy, brachytherapy and recent advances in radiotherapy techniques. Topics also include focus on internal dosimetry with respect to absorbed dose in critical organs, use of MIRD tables and recent advances in nuclear medicine

ZCT 534/4 Physics Diagnostic Of Radiology

The course explains: i the physics principles of X-ray generators; X-ray spectra, beam filtration; interaction of X-rays in the body; film screen radiography; fluoroscopy; tomography, mammography; digital radiography; Xerography; ionography; transmission computed tomography; emission computer assisted tomography – SPECT and PET; ii techniques and principals to perform quality control test for radiographic X-ray machine, iii image reconstruction techniques; iv radiation risks and hazards in diagnostic radiology.

ZCT 535/4 Nuclear Medicine And Radiotherapy Physics

The radiotherapy component comprises of: Introduction to radiotherapy; Principles of operation of radiotherapy treatment units; Characterisation of photon beams; dose distributionin tissue produced by external photon beams; Treatment and dose modification techniques with photon beams; Treatment planning and dose delivery Electron beam therapy- production,dose distribution and plannning; Brachytherapy – dosimetry, dosage systems; Recent advances in radiotherapy techniques- IMRT, IGRT. The nuclear medicine component comprises of: Physiological basis of nuclear medicine; dilution method; radionuclide labeling techniques; Principles of gamma ray imaging; Physiological – v anatomical imaging; dynamic imaging; Rectilinear scanners; Multricrystal and hybrid scanners; The Auger camera, collimator design; Internal dosimetry; Biochemical factors, physical considerations, critical organs, absorbed fraction; Medical Internal Radiation Dosimetry (MIRD) recommendations and the use of MIRD tables.

MSc. (MEDICAL PHYSICS)

ZCT 595/8 Project

This course aims to provide an oportunity for students to intergrate their knowledge in medical physics to work on an independent medical physics project. Students are required to write a scientific report on the project. A seminar on the research project must be presented followed by a viva-voce session.

ZCT 596/Medical Physics Practical I

The course equip students with practical training on selected medical physics topics; measurements, detection, absorption and scattering of radiation; the quality control of X-ray machine; and film processing and dose measurements in chest phantom. This course also aims to further develop students' scientific report writing skill.

ZCT 596/Medical Physics Practical II

The course equip students with practical training on selected medical physics topics: magnetic resonance imaging and ultrasonic; characterization of materials; nuclear medicine and radiotherapy. This course also aims to further develop students' scientific report writing skill.

MSc. (RADIATION SCIENCE)

ZCT 532/4 Radiation Physics

This course introduces students to the atom structure and the origin of radiation. Explain different ways of radiation interaction with matter. Relate the radiation transport behaviour in matter to the attenuation coefficients of each material and radiation energy. Describe different ways of particle accelerators. Explain the methods of radiation detection systems for different types and energies of radiation. The course includes also the production of radioactive isotopes by neutron activation.

ZCT 533/4 Dosimetry And Radiation Protection

This course provides an introduction on operation principles of radiotherapy treatment units, radionuclide labeling techniques and gamma ray imaging. The course emphasizes on dose distribution in tissue produced by external photon beams treatment and dose modification techniques with photon beams; treatment planning and dose delivery electron beam therapy, brachytherapy and recent advances in radiotherapy techniques. Topics also include focus on internal dosimetry with respect to absorbed dose in critical organs, use of MIRD tables and recent advances in nuclear medicine

ZCT 551/4 Radiation Protection I

This course follows the ICRP's conceptual framework and international recommendations on radiation protection and the safe use of radiation sources. The syllabus provides the concept of external and internal exposure and use of the occupational radiation protection concepts in developing radiation protection programme for any practices.

ZCT 551/4 Radiation Protection II

This course explains the basic principles on medical radiation exposure in diagnostic radiology, radiotherapy and nuclear medicine, radiation exposure to the public on the practice and handling of radiation sources usage. The course also aims to demonstrate clearly on interventions in situations of chronic exposure and emergency. It includes topics relevant for trainers that are providing training in the related fields.

ZCT 599/4 Practical

Practical training in selected topics includes radiation detection and measurements, radiation absorption and scattering, the quality control of X-ray machine and film processing and characterisation of materials using the absorption and scattering of g-rays. This course also trains student in the analysis of data and the writing of practical reports.

ZCT 598/20 Dissertation

This course aims to provide an oportunity for students to intergrate their knowledge in radiation science to work on an independent radiation science project. Students are required to compose related literature review, display and defend research project in a seminar and viva-voce. Students are required to submit a dissertation on the project.

MASTER OF SCIENCE SOLID STATE PHYSICS

ZCC541/4 Solid State Physics I

Course Synopsis:
Periodic structures of solids and Brillouin Zones. Free electron gas and Sommerfeld theory of metals. Quantum mechanical states of single electron in periodic structures, Bloch Theorem and Fermi Surface. Quantum mechanical methods, time independent perturbation theory and transition probabilities. Band structure of solids, methods of calculating band structure and tight binding method. Dynamics of electrons in solids, effects of static electric and magnetic fields, concept of holes, Dielectric function, Microscopic and macroscopic Maxwell Equations, linear isotropic media, screened potential and screening length, qualitative discussion of Hartree and Hartree-Fock equations and Lindhard function. Lattice vibrations, elementary excitations, phonon, phonon creation, thermal properties of solids, measurement of phonon dispersion relations.

ZCC542/4 Solid State Physics II

Course Synopsis:
Mathematical review, thermodynamics, optics of bulk isotropic media, optics of bulk anisotropic media, ferroelectricity, liquid crystal, magnetism and superconductivity.

ZCC543/4 Semiconductor Physics

Course Synopsis:
The course covers the important topics in semiconductor physics which include electronic energy band structure, defects and impurities, charge carriers, carrier transport, effect of high electric field and magnetic field on carrier transport, carrier scattering and trapping process, optical properties of semiconductors, effects of quantum confinement in modern nano scale semiconductor devices and low dimensional structures and amorphous semiconductors.

ZSC548/4 X-ray Structure Analysis

Course Synopsis:
X-ray Analysis: background, single crystal and powder, X-ray tube, X-ray generation, X-ray usage. X-ray Interaction with matter: coherent diffraction, incoherent diffraction, photoelectron, fluorescence X-ray, Auger electron. Powder diffraction: why powder, difficulties and limitations, powder diffraction pattern, qualitative analysis. Introduction to X-r ay structure determination: sample requirement, sample mounting, X-ray tube choices, data collection, data refinement, structure determination. X-ray crystallography method: characteristic and continuous X-ray, absorption and filter. Crystal system and symmetry: basic symmetry operation, crystal class, Bravais lattice. Space group analysis: crystallography axes, stereographic projection. Symmetry element: reciprocal lattice, screw axes, glide plane. Point group analysis. Single Crystal Structure Analysis.

ZCC549/4 Physics of Optical Communication

Course Synopsis:
Introduction and History of Optical Communication. Physics of Optical Fibre Material. Waveguide and waveguide devices. Design and fabrication of optical fibre and also fibre loses. Principle and Operation of Optical Components. Optical Communication System. Principles and Operation of Optical Sensors.

MASTER OF SCIENCE SOLID STATE PHYSICS

ZCC591/4 Measurements and Experimental Techniques I

Course Synopsis:
Students are required to conduct 4 out of total 8 experiments related to solid state physics including: a. Cryogenic, b. Porous Silicon, c. Contact Resistivity Measurement, d. Optical Network Analysis, e. Erbium Doped Amplifier, f. Hall Effect, g. CV-MOS, h. Crystallography

ZCC592/4 Measurements and Experimental Techniques II

Course Synopsis:
Students are required to conduct the remaining 4 experiments continuation from ZCC591/4 related to solid state physics including: a. Cryogenic, b. Porous Silicon, c. Contact Resistivity Measurement, d. Optical Network Analysis, e. Erbium Doped Amplifier, f. Hall Effect, g. CV-MOS, h. Crystallography

ZSC546/4 Semiconductor Devices

Course Synopsis:
Crystal structure, reciprocal lattice and Brillouin zone. Energy bands and energy bands of semiconductor. Carrier drift – mobility, resistivity, Hall Effect. Carrier diffusion - Einstein relation and current density equations. Generation and recombination processes. Recombination. Continuity equation. Tunneling process, high-field effects, P-N junction. Depletion region and depletion capacitance. Current-voltage characteristics, charge storage and transient behaviour. Junction breakdown – tunneling effect, avalanche multiplication. Introduction to heterojunction. Bipolar transistor and static characteristics of bipolar transistor. Heterojunction bipolar transistor and thyristor. The MOS diode and SiO2-Si MOS diode.The charge-coupled device (CCD). MOSFET fundamentals, types of MOSFETS, thin film transistor (TFT), DRAM, SRAM. Basic microwave technology and tunnel diode. IMPATT diode and transferred-electron devices. Resonant tunneling diode and hot-electron HBT. Transferred-electron devices and hot-electron HBT. Photonic devices. Light-emitting diodes, semiconductor laser and distributed feedback lasers. Photodetector, solar cell and compound-semiconductor solar cells.

ZCC593/8 Project

Course Synopsis:
This course will focus on the ability of the students to conduct their own scientific project using the knowledge that they have acquired and apply it to the implementation of the project. The project title will be given by the lecturer on the basis of his/her discretion or mutual agreement between lecturer and students. The duration of project will be two semesters, i.e. 2nd and 3rd (short). Students will register in the 2nd semester.

Master of Science (Physics) and Doctor of Philosophy

This Programme includes research on various fields. The fields offered are as followed:-

Research Thrust Areas

A) Applied and Engineering Physics
- Semiconductor Fabrication (Thin Film, Epitaxy and Nano structures)
- Sensors and Actuators
- Digital Image Processing (Land Cover Mapping, Water and Air Quality Monitoring)
- Optical and Remote Sensing Technology
- Photonic Devices, Systems and Applications
- Thermal Processes in Device and Packaging

B) Condensed Matter Physics and X-ray Crystallography
- Materials Fabrication and Characterization for Electronics, Optoelectronics and Biomedicine
- Studies of Condensed Matter Materials and Devices
- Photonic Materials and Devices
- Modelling and Simulation of Condensed Matter Devices
- X-ray Structure Determination and Characterization (Organic/Organometallic Compounds, Non-linear Optical Materials, Natural Products)

C) Energy Studies
- Solar Thermal and Photovoltaic
- Computer Simulation and Modelling of Solar Energy
- Bioenergy
- Fuel Cell and Batteries

D) Geophysics, Astronomy and Atmospheric Science
- Exploration Geophysics
- Physical Oceanography
- Environmental Remote Sensing (Land and Water)
- Positional Astronomy
- Photometric and Spectroscopic Studies
- Ozone Studies
- Atmospheric Studies
- Meteorology
- Atmospheric Remote Sensing
- Radioastronomy
- Astrophysics

E) Medical Physics and Radiation Science
- Radiation Dosimetry, Radiation Protection (Monte Carlo Methods, Non-destructive Testing)
- Medical Instrumentation (Lasers, Ultrasound, MRI, CT, Nuclear Medicine, Imaging Techniques)
- Radiation Physics
- Biophysics (Radiation, Cardiovascular, Cellular)

F) Theoretical and Computational Physics
- Computational Condensed Matter Physics
- Linear and Nonlinear Optics
- Theoretical Condensed Matter Physics (Magnetic, Ferroelectric Materials and Liquid Crystals)
- High Energy Physics (Non-Abelian Gauge Theory, Elementary Particles)

Synopsis

A) APPLIED AND ENGINEERING PHYSICS

Research in these areas involves the application of fundamental theory of physics to explain and solve problems of applied physics and engineering physics for the development of new technologies. The main research topics include semiconductor fabrication, sensors and actuators, thermal processes in device and packaging, digital image processing, optical and remote sensing technology, and photonic devices, system and applications. Related laboratories are well equipped with sophisticated and up to date equipments for forefront research. Graduate students are encouraged to present their research work at national and international conferences and publish in high impact factor journals.

1. Areas of Emphasis in Graduate Study and Research

Semiconductor Fabrication (Thin Film, Epitaxy and Nanostructures)

The research areas cover fundamental growth and properties of materials up to nanolithography and optoelectronic devices. Examples of topics of interest are thin semiconductor, insulator and metal films, growth, interface states and characterization; fabrication, characterization and theoretical simulation studies; fabrication and characterization of quantum well (QW) structures and novel optoelectronic devices; wide band gap semiconductor materials and devices; theoretical modeling of nanophotonic devices; fabrication of photonic crystal devices by self-assembly of nanoparticles; and optical characterizations of novel luminescent materials and photonic crystals. Examples of current research projects are the fabrication and characterization of wide band gap III-nitride semiconductors and metal oxide nanostructures.

2. Sensors and Actuators

There are various research topics covered in sensors and actuators such as electric current and potential, environment, weather, moisture, humidity, position, optical, light, imaging, pressure, force, density, thermal, and etc. In addition, the objective of this type of research interest is to develop the sensing concepts that take advantage of the small feature sizes enabled by micro and nanotechnologies. The new sensing concepts either rely on small-scale effects or they allow integration of miniaturized devices into engineering systems. Graduate students are encouraged to develop and investigate the innovative valve sensors and actuators. Besides that, electronic circuits can be designed to improve or complement the characteristics of sensors and actuators devices.

3. Thermal Processes in Device and Packaging

Research in thermal process covers the large and increasing number of advanced thermal management and packaging materials, manufacturing processes, applications, cost, and future development. In addition, advanced materials will be increasingly important for 3D packages as heat loads increase. In future applications, developed and well established advance technology are needed for the control of thermal processes in device and packaging.

4. Digital Image Processing

Research project focuses on the development of digital image system such as processors, digitizer, digital computer, storage, display and scanner. Besides that, research study in digital processing also included the image enhancement, image representation and description, histogramming, smoothing, sharpening, thresholding, edge detection, spatial mask and linking. Graduate students are encouraged to explore new technology in industrial vision system, automated visual inspection, process control and assembly application.

5. Optical and Remote Sensing Technology

This research area mainly focuses on the development of innovative new optical and remote sensor capable to be applied in several fields, for instance in the study of water turbidity, air pollution, waste water and thermal distribution. Novel sensing technology is invented to substitute the conventional technology and plays an important role in improving the development of current sensing capability.

6. Photonic Devices, System and Applications

Research in this group involves the development of new technologies for photonic devices and systems and increase of the level of applied research. For the development of photonics and its applications, it is necessary to analyses the nonlinear optical processes involved and investigate suitable materials for light generation, guiding and detection. This research area has true scientific value and potential for applications in the area of information technologies, environmental protection and health and quality of life improvement. Optical instruments include microscopes, interferometer, radiometer and cameras spectrometers.

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Dr. Adilah Shariff
Dr. Ahmad Fairuz Omar
Dr. Mohd Mahadi Halim
Dr. Nurhayati Abdullah
Dr. Tan Kok Chooi
Dr. Wan Maryam Wan Ahmad Kamil
Dr. Yam Fong Kwong
Mr. Wong Chow Jeng

B) CONDENSED MATTER PHYSICS AND X-RAY CRYSTALLOGRAPHY

Researches in Condensed Matter Physics and X-ray Crystallography group extend from a fundamental aspect of materials analysis to its potential applications. The researches done within this group are intended to discover and understand the materials and their properties through various experiment, computation, simulation and theoretical methods. Research laboratories are equipped with various specialized equipments. These discoveries and understanding of materials that could also lead to enhancement and control of materials properties will result in new fundamental knowledge, materials or products.

The main research focuses of this group are:

1. **Materials Fabrication and Characterization for Electronics, Optoelectronics and Biomedicine**
2. **Studies of Condensed Matter Materials and Devices**
3. **Photonic Materials and Devices**
4. **Modeling and Simulation of Condensed Matter Devices**
5. **X-ray Structure Determination and Characterization (Organic/Organometallic Compounds, Non-linear Optical Materials, Natural Products)**

For more information, please contact:

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Professor Dr. Haslan Abu Hassan
Associate Professor Dr. Lim Siew Choo
Associate Professor Dr. Ong Lye Hock
Associate Professor Dr. Shahrom Mahmud
Dr. Subramani Shanmugam
Dr. Suhana Arshad
Dr. Yam Fong Kwong

C) ENERGY STUDIES

Energy Studies research is directed towards research in solar energy, in particular, solar photovoltaic, solar thermal and bioenergy. Research in solar photovoltaic covers fabrication of solar cells and modules, electrical power system, and computer modeling. Thermal research includes solar thermal system design, hot water system, drying system, air-conditioning, and computer modeling. Bioenergy research includes utilization of biomass and wastes, and production of solid and liquid biofuels by fast and slow pyrolysis.

In a simple form, below are research interests in energy studies area:

1. **Bioenergy**
2. **Computer simulation and modeling of solar energy**
3. **Fuel cell and batteries**
4. **Solar thermal and photovoltaic**
5. **Thermal processes in device and packaging**

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Associate Professor Dr. Mutharasu Devarajan
Dr. Nurhayati Abdullah

D) GEOPHYSICS, ASTRONOMY AND ATMOSPHERIC SCIENCE

The Group's philosophy and objective has been to pursue excellence by concentrating its research initiatives in specific areas of the Geosciences. Graduate students benefit from greater focus and also enjoy close interaction with faculty members. A distinctive aspect of graduate study in the Geosciences Department is the opportunity for collaborative research, often involving several faculty members. Graduate studies, either Ph.D. and M.S. thesis-based programs, are offered with concentrations in areas including environmental and engineering geophysics, remote sensing applications, nearshore and coastal oceanography, petroleum geoscience and reservoir sedimentology, and meteorology.
The Geophysics Group occupies a modern, well-equipped building that houses experimental and analytical labs, faculty and graduate student offices, numerous computers and workstations. The group also owns a complete range of geophysical tools such as multielectrode resistivity and electromagnetic tools, ground penetrating radar and magnetic measurements meters.

1. Areas of Emphasis in Graduate Study and Research:
Engineering and Environmental Geophysics
Research within this sub-discipline involves the applications and utilization of the science of geophysics to environmental and engineering problems. Students will be exposed to the use of various specialized geophysical tools to solve subsurface problems. The group has extensive experience in applications of geophysical measurements to environmental and engineering problems. Examples include the investigation of industrial, military and abandoned waste disposal sites or on landfills, building sites and traffic routes, as well as mapping ground water pollution.

The USM Geophysics Group owns a complete range of geophysical tools such as multielectrode resistivity and electromagnetic, ground penetrating radar and magnetic measurements.

2. Remote Sensing Applications
Remote sensing research at the USM Geophysics Group focuses on the theory, concepts, and techniques of science and engineering as applied to sensing the earth, oceans, atmosphere, and space; and the processing, interpretation, and dissemination of this information. Projects undertaken are of multi-disciplinary collaborative research, often involving several faculty members. Examples include the use of satellite images in mapping estuarine coastal plume pattern, coastline changes and coastal reclamation, haze and air pollution studies.

3. Petroleum Geoscience: Sedimentary Geology and Reservoir Characteristic
Research projects in sedimentary and reservoir geology focuses on the integration of petrophysical parameters with field geophysical, sedimentological, and stratigraphic studies.Sedimentologicalfacies and stratigraphic characteristics obtained from field studies provide information concerning the depositional processes and paleoenvironment of sedimentary bodies, their relative age, geometry and probable lateral extent, which yield insight to broader issues of relative sea level change, structural geological history and basin evolution. Shallow geophysical studies of Quaternary successions (coastal and deltaic) generate images of recent sedimentary successions, revealing their geometry and (sequence) stratigraphic organizations. Integrating petrophysical data (porosity, permeability, density and rock velocity) into these larger scale stratigraphic frameworks allow us to visualize fluid behaviour and movements within different types reservoir sedimentary bodies, and determine the different factors that control the flow. The group main focus is the tertiary reservoir and non-reservoir succession in Sabah and Sarawak, East Malaysia. Analytical facilities include scanning electron microprobe (SEM), optical petrography, X-ray diffraction facilities, and a variety of other facilities at the School of Physics.

4. Nearshore and Coastal Oceanography

Knowledge of processes and patterns in the oceans is fundamental to understanding how the marine environment interacts with the rest of the planet. This knowledge can only be gathered through long term oceanographic research. We rely on ocean research to manage living and non-living marine resources in a sustainable and effective way, ensure national security without compromising ecosystem protections, and minimize the human impacts of natural hazards ranging from hurricanes and tsunamis to coastal erosion and global climate change.

One key focus of the oceanographic research team is estuary. Estuaries are key environmental and economic resources, supporting tourism, recreation, fishing, and shipping industries. For the last ten years, the group has been collecting data on the three major estuaries in Seberang Perai and Kedah, which lies on the northern west coast of Peninsular Malaysia.

5. Meteorological and Atmospheric Sciences

The objective of this group is to advance the science of meteorology with particular emphasis on the Malaysian and the Southeast Asian region, and to advance the national interest through meteorological and oceanographic research.

For more information, please contact:

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Associate Professor Dr. Rosli Saad
Dr. Amin Esmail Khalil
Dr. Andy Anderson Bery
Dr. Ismail bin Ahmad Abir
Dr. Md. Noordin Abu Bakar
Dr. Nordiana Mohd Muztaza
Dr. Norhaslinda Mohamed Tahrin
Dr. Nur Azwin Ismail
Dr. Teoh Ying Jia
Mr. Wong Chow Jeng

E) MEDICAL PHYSICS AND RADIATION SCIENCE

Medical Physics is the application of physics to problems involving human health. Most of the research work of the group is an applied nature and covers a wide range of topics, since a broad range of activities is encompassed by the fields of Medical Physics. On the same note, the area of Radiation Science is designed to provide both theoretical and practical in the multidisciplinary scientific and/or technical aspects of radiation protection and the safety of radiation sources.

The Medical Physics and Radiation Science research can be broadly categorized into four main areas:

1. **Biophysics (Radiation, Cardiovascular, Cellular)**
2. **Medical Instrumentation (Lasers, Ultrasound, MRI, CT, Nuclear Medicine, Imaging Technique)**
3. **Radiation Dosimetry, Radiation Protection (Monte Carlo Methods, Non-destructive Testing)**
4. **Radiation Physics**

One of the many attractions of research in Medical Physics is that it involves working in a multi-disciplinary environment. Graduate research in Medical Physics and Radiation Science are offered at the M.Sc. and Ph.D. levels. Graduate students are encouraged to present their research findings at national and international conferences and other Physics meetings.

For more information, please contact

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Dr. Azhar Abdul Rahman
Dr. Iskandar Shahrim Mustafa
Dr. Nik Noor Ashikin Nik Ab Razak
Dr. Nursakinah Suardi
Dr. Nurul Zahirah Noor Azman
Dr. Ramzun Maizan Ramli

F) THEORETICAL AND COMPUTATIONAL PHYSICS

The Group comprises five academic staff and they involve actively in the following fields:

1. **Condensed Matter:**
   i) Phenomenological theory on: switching and dynamic properties of thin films, multilayer and super lattices in ferroelectrics; second harmonic generation in ferroelectric thin films; optical bistability of ferroelectric and liquid crystal films, phase transitions and electric field effect in ferroelectric and antiferroelectric liquid crystals.
   ii) Computational Physics on ferroelectrics and other solid state materials.

2. **High Energy Physics and Cosmology:**
   Physics of neutrino mass, configurations of the monopole solutions of the SU(2) Yang-Mills-Higgs theory particle physics implications on cosmology.

   Members of the group have published in major SCI journals over the years; and some of these articles in theoretical condensed matter physics, nuclear and high energy physics have been cited by their peers internationally.

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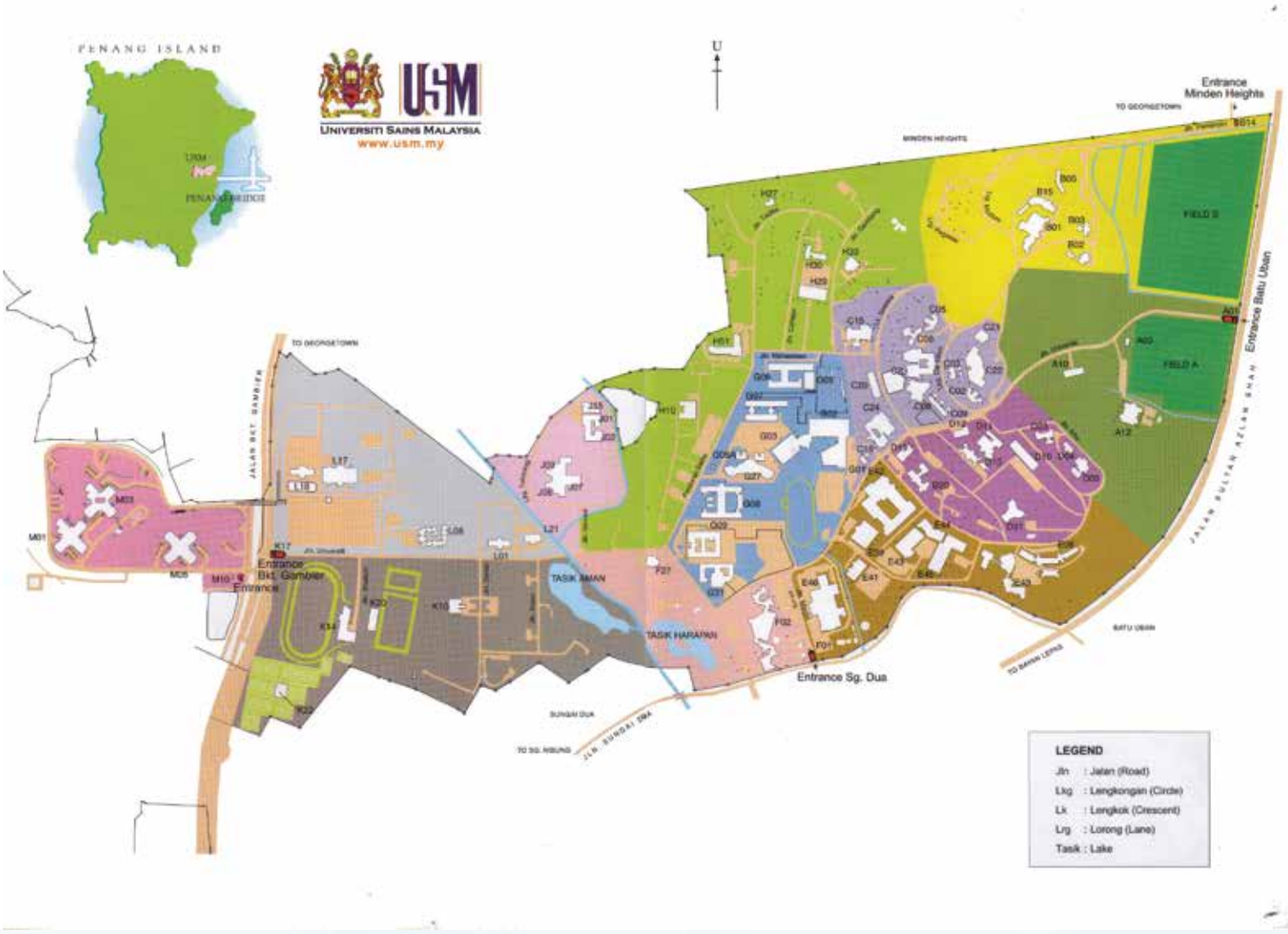
Associate Professor Dr. Lim Siew Choo
Dr. Mohd Mahadi Halim
Dr. Saiful Najmee Mohamad
Dr. Wong Khai Ming

Expertise available in the following School:

School of Physics
www.fizik.usm.my/
or
http://experts.usm.my/

Campus Map

The School of Physics is situated at the Universiti Sains Malaysia's main campus. The School of Physics which occupies Building G06 was one of the three Schools that was set up when the University was established in the year 1969.



Detailed maps can be found at: http://maps.usm.my/campus/

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