MSc Physics with Specialisation in Computing and Applications - SC534 (Subject to Approval)

1. Specific Titles

1) MSc Physics with Specialisation in Computing and Applications
2) Postgraduate Diploma in Physics with Specialisation in Computing and Applications
3) Postgraduate Certificate in Physics with Specialisation in Computing and Applications

2. Objectives

Real-life physical processes occurring in our environment are complex, resulting from the interplay of a multitude of different phenomena. With the increased accessibility to computing power at low/reasonable cost, additional opportunities for the holistic study of these complex physical phenomena have cropped up. Physicists can now make use of extensive mathematical and computational tools which were not available before. New models for various aspects of nature, with a large number of parameters can be simulated without substantial simplification. This has resulted in the rapidly growing discipline of Computer Applications in Physics which unites the power of computers and the physical sciences.

Therefore, nowadays computer-based simulations and graphic visualization are important aspects of research/investigations in Physics. The MSc Physics with Computing and Applications aims at providing graduates with a solid knowledge of the topics and enhancing their knowledge and skills in this emerging and fast developing field. The study of physical principles, mathematical techniques, numerical models and computational methods and tools thus make up the core of this programme. After having successfully completed the programme, the graduates will have knowledge and skills needed to benefit from a better career prospect or to embark easily in various research programmes.

3. General Entry Requirements

Successful completion of an undergraduate degree with

- at least a Second Class or CPA $\geq$ 50%, whichever is applicable or
- a GPA not less than 2.5 out of 4 or equivalent, from a recognised higher education institution.

OR alternative qualifications acceptable to the University of Mauritius.

4. Programme Requirements

BSc (Hons) Physics or BSc **(**Joint Hons) Degree with Physics as one of the subjects or equivalent qualifications acceptable to the University of Mauritius.

5. General and Programme Requirements – Special Cases

The following may be deemed to have satisfied the General and Programme requirements for admission:

(i) Applicants who do not satisfy any of the requirements as per Regulations 3 and 4 above but who submit satisfactory evidence of having passed examinations which are deemed by the Senate to be equivalent to any of those listed.

(ii) Applicants who do not satisfy any of the requirements as per Regulations 3 and 4 above but who in the opinion of Senate submit satisfactory evidence of the capacity and attainments requisite to enable them to pursue the programme proposed.

(iii) Applicants who hold a full practising professional qualification obtained by examination.

6. Programme Duration

The Programme is offered either on a full-time (F/T) and/or a part-time (P/T) basis. The duration of the Postgraduate Programme should normally not exceed 2 years (4 semesters) for F/T and 4 years (8 semesters) for P/T.

7. Credits per Semester: Minimum 3 credits subject to Regulation 6.

8. Minimum Credits Required for Awards

Master's Degree: 39
Postgraduate Diploma: 24
Postgraduate Certificate: 12

Breakdown as follows:

	Core Taught modules	Project	Electives
Master's Degree	18	12	9[a]
Postgraduate Diploma	18		6[b]
Postgraduate Certificate	12		

[a] A minimum of 9 credits from departmental electives including at least 6 credits from electives with a PHYCO code.

[b] A minimum of 6 credits from departmental electives including at least 3 credits from electives with a PHYCO code.

9. Assessment

Each module can either be taught in semester 1 only or in semester 2 only or throughout the two semesters.

Modules wholly taught in one semester are termed semester modules whereas modules taught throughout the two semesters are termed yearly modules.

Each module will carry 100 marks and will be assessed as follows (unless otherwise specified):

Assessment will be based on a written examination of 3-hour duration and continuous assessment carrying a range of 30% to 40% of total marks. Continuous assessment may be based on laboratory works and/or assignments and/or seminars and should include at least 1 class test.

Written examinations for semester modules will be held in the semester they are taught in. Yearly modules will be examined at the end of the year.

An overall total of 40% for combined Continuous Assessment and Written Examination components would be required to pass a module, without minimum thresholds within the individual Continuous Assessment and Written Examination.

10. Plan of Study

Students are required to submit at the end of Semester 1 a Plan of Study for their whole Programme of Studies, indicating the list of electives modules and in which semester each of them will be taken.

The University reserves the right not to offer a given elective module if the critical number of students is not attained and/or for reasons of resource constraints.

11. Important Note

The rules as stipulated in this Programme Structure and Outline Syllabus will replace all other rules and regulations found in previous Programme Structures.

12. List of Modules

Code	Module Name	Hrs/Wk L + P	Credits
CORE MODULES			
PHYSI 6001(7)	Electromagnetic Phenomena	3 + 0	3
PHYSI 6002(7)	Quantum Mechanics II	3 + 0	3
PHYSI 6003(7)	Statistical Mechanics	3 + 0	3
PHYSI 6004(7)	Optics and Photonics	3 + 0	3
PHYCO 6001(7)	Fundamentals of Computer Simulations	2 + 2	3
PHYCO 6002(7)	Advanced Signal Processing	2 + 2	3
PROJECT			
PHYSI 6000Y(7)	Research Project	-	12
ELECTIVES			
PHYCO 6003(7)	Computer-Oriented Statistical Physics	2 + 2	3
PHYCO 6004(7)	Applied Computational Fluid Dynamics	2 + 2	3
PHYCO 6005(7)	Computational Electromagnetics	2 + 2	3
PHYCO 6006(7)	Quantum Computation, Communication & Cryptography	2 + 2	3
PHYCO 6007(7)	Imaging Materials and Processes	2 + 2	3
PHYCO 6008(7)	Image Processing & Computer Vision	2 + 2	3

And/or other modules approved by the department.

Note: Not all electives may be on offer. The list of modules is not exhaustive.

13. Programme Plan - MSc Physics with Specialisation in Computing and Applications

Full-Time

YEAR 1

Code	Module Name	Hrs/Wk L+P	Credits
CORE			
PHYSI 6000Y(7)	Research Project	-	-
PHYSI 6001(7)	Electromagnetic Phenomena	3 + 0	3
PHYSI 6002(7)	Quantum Mechanics II	3 + 0	3
PHYSI 6003(7)	Statistical Mechanics	3 + 0	3
PHYSI 6004(7)	Optics and Photonics	3 + 0	3
PHYCO 6001(7)	Fundamentals of Computer Simulations	2 + 2	3
PHYCO 6002(7)	Advanced Signal Processing	2 + 2	3
ELECTIVES			
PHYCO 6003(7)	Computer-Oriented Statistical Physics	2 + 2	3
PHYCO 6004(7)	Applied Computational Fluid Dynamics	2 + 2	3
PHYCO 6005(7)	Computational Electromagnetics	2 + 2	3
PHYCO 6006(7)	Quantum Computation, Communication &	2 + 2	3

	Cryptography		
PHYCO 6007(7)	Imaging Materials and Processes	2 + 2	3
PHYCO 6008(7)	Image Processing & Computer Vision	2 + 2	3

And/or other modules approved by the department.

Note: Not all electives may be on offer. The list of modules is not exhaustive.

Part-Time

YEAR 1

Code	Module Name	Hrs/Wk L+P	Credits
CORE			
PHYSI 6001(7)	Electromagnetic Phenomena	3 + 0	3
PHYSI 6002(7)	Quantum Mechanics II	3 + 0	3
PHYSI 6003(7)	Statistical Mechanics	3 + 0	3
PHYSI 6004(7)	Optics and Photonics	3 + 0	3
PHYCO 6001(7)	Fundamentals of Computer Simulations	2 + 2	3
PHYCO 6002(7)	Advanced Signal Processing	2 + 2	3

YEAR 2

Code	Module Name	Hrs/Wk L+P	Credits
CORE			
PHYSI 6000Y(7)	Research Project	-	-
ELECTIVES			
PHYCO 6003(7)	Computer-Oriented Statistical Physics	2 + 2	3
PHYCO 6004(7)	Applied Computational Fluid Dynamics	2 + 2	3
PHYCO 6005(7)	Computational Electromagnetics	2 + 2	3
PHYCO 6006(7)	Quantum Computation, Communication & Cryptography	2 + 2	3
PHYCO 6007(7)	Imaging Materials and Processes	2 + 2	3
PHYCO 6008(7)	Image Processing & Computer Vision	2 + 2	3

And/or other modules approved by the department.

Note: Not all electives may be on offer. The list of modules is not exhaustive.

14. Outline Syllabus

This outline syllabus is not prescriptive and is intended to serve as a guide only.

CORE MODULES

PHYSI 6000Y(7) - RESEARCH PROJECT
The student must undertake a research project work on a topic approved by the department.

PHYSI 6001(7) - ELECTROMAGNETIC PHENOMENA
Electromagnetic wave equation. Electromagnetic wave propagation. Generation (and sources) of electromagnetic waves. Polarisation. Interference. Diffraction. Electromagnetic wave scattering. Electromagnetic fields. Electromagnetic radiation.

PHYSI 6002(7) - QUANTUM MECHANICS II
Introduction: concepts of quantum mechanics and conservation laws in quantum mechanics. Perturbation theory: time independent and time dependent. Spin. Identity of particles. Radiation from atoms. Some selected topics.

PHYSI 6003(7) - STATISTICAL MECHANICS
Thermodynamics. Statistical methods. Systems & particles. Statistical thermodynamics. Ensembles. Quantum statistics. Fluctuations. Phase transitions. Applications.

PHYSI 6004(7) - OPTICS AND PHOTONICS
Review of basic concepts. Geometrical optics. Coherence theory. Fourier optics. Optical systems. Lasers. Imaging. Holography. Guided optics and optical devices**.**

PHYCO 6001(7) - FUNDAMENTALS OF COMPUTER SIMULATIONS
Importance of computer simulations in Physics. Review of basic numerical tools for solving problems in Physics: Solution of differential equations, matrix operations & eigenvalue problems, interpolation and numerical integration, modelling of data and Monte Carlo methods. Python Programming. Data storage, processing and visualization using Matlab. Model enhancement using high performance scientific computing.

PHYCO 6002(7) - ADVANCED SIGNAL PROCESSING
Analogue and digital signals. Noise. Filtering. Sampling (Nyquist theorem). Digitisation. Correlation. Transforms. Convolution & Deconvolution techniques. Spectral analysis. Component analysis. Applications.

ELECTIVE MODULES

PHYCO 6003(7) - COMPUTER-ORIENTED STATISTICAL PHYSICS
Review of Thermodynamics and Statistical mechanics. Equilibrium Monte Carlo Simulations: Ising Model, Metropolis, Glauber and Kawasaky algorithms. Non-equilibrium Monte-Carlo simulations: directed percolation and kinetically constrained models. Off-Lattice Simulations: cluster algorithm and molecular dynamics. Langevin and KPZ Dynamics.

PHYCO 6004(7) - APPLIED COMPUTATIONAL FLUID DYNAMICS
Fluid mechanics: Concept of continuum, streamlines, streaklines and pathlines, Buoyancy, Lagrangian and Eulerian descriptions, conservation equations. Fundamentals of Finite Difference, Finite Volume and Finite Element Methods. The SIMPLE scheme. Turbulence modelling. Application to some classical problems.

PHYCO 6005(7) - COMPUTATIONAL ELECTROMAGNETICS
Review of Electromagnetic fields and waves: Maxwell's equations, wave equations and wave propagation. Theory and use of finite-difference time-domain method; Yee algorithm; numerical dispersion; absorbing boundary conditions; Incident Wave Source Conditions for Free Space and Waveguides; scattering; radiation; time domain vs. frequency domain. Near to far field transformation. Applications.

PHYCO 6006(7) - QUANTUM COMPUTATION, COMMUNICATION & CRYPTOGRAPHY
Basic principles of quantum mechanics. Quantum gates and circuits. Classical computation versus quantum computation. Entanglement. Quantum algorithms: Shor's factoring and discrete logarithm; Grover's search; simulation. Classical and quantum information theory, quantum cryptography, teleportation, dense coding. Error correction and fault-tolerant quantum computing. Physical realizations: nuclear magnetic resonance; ions in traps; solid state devices.

PHYCO 6007(7) - IMAGING MATERIALS AND PROCESSES
Images & imaging. Colour & photography. Imaging materials & systems. Scanning. Digitisation. Compression. Transmission. Recording. Storage. Stability & preservation. Applications.

PHYCO 6008(7) - IMAGE PROCESSING & COMPUTER VISION
Imaging and image representation. Image fundamentals. Transformations and operations. Noise. Component analysis. Image analysis. Shape analysis and object recognition. Image filtering and enhancement.

Segmentation. Matching. Image sequences. Image databases. Perceiving 3D from 2D images. Virtual reality. Applications.

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