POSTGRADUATE INSTITUTE OF SCIENCE
UNIVERSITY OF PERADENIYA

M.Sc. Programme in Nanoscience and Nanotechnology (Course work – SLQF Level 9)

M.Sc. Programme in Nanoscience and Nanotechnology (Course work and Research – SLQF Level 10)

1. INTRODUCTION

Nanoscience and Nanotechnology are fast growing areas of Science and Technology which span the entire spectrum of science and technology including next generation electronics, engineering materials, advanced materials and coatings, devices, computers, medicine, textiles, sports equipment, polymers, biology, agriculture, food science, etc. The western countries as well as our neighbouring countries such as India, Thailand, Korea, Singapore, etc. have already taken steps to train manpower to carry out Research and Development (R&D) activities on this fast growing area of science. Nanotechnology is considered the next generation Industrial Revolution without which the industrial sector cannot sustain. Sri Lankan state and private sectors are highly enthusiastic on developing nanotechnological research and development activities and to facilitate this task, Sri Lanka Institute for Nanotechnology (SLINTEC) has already been formed. The M.Sc. programme will cover a broad range of disciplines to enable the trained graduates to make an objective judgment of the scientific importance and technological potential of developments in micro- and nanotechnologies and to perform a range of activities related to Nanoscience and Nanotechnology. The study programme will thus prepare the student to take the challenge of meeting not only national needs in diverse areas of nanoscience and nanotechnology but also to continue toward advanced studies anywhere in the world

2. OBJECTIVES OF THE PROGRAMME

To provide

- a sound theoretical foundation on important techniques of nanotechnology and nanoscience.
- the training in using, troubleshooting and maintenance of nanotechnological experiments, research and applications.
- strong knowledge on synthesis, characterisation, and analysis of nanomaterials leading to appropriate nanotechnological application.
- adequate knowledge on the principles of nanotechnology and nanoscience.

3. PROGRAMME ELIGIBILITY

Candidates having a bachelor's degree with 30 credits including relevant modules of Chemistry and/or Physics or equivalent accredited prior learning experience are eligible to follow the programme. *Those who do not possess the necessary background in the discipline(s) of Nanotechnology may have to follow additional courses as described by the relevant Board of Study prior to the commencement of the postgraduate programme*.* Eligible applicants shall face a selection examination followed by an interview, conducted by the PGIS. Employed candidates eligible for admission should produce evidence of leave granted to follow the programme and a letter of release from the Head of the Department/Institution.

4. PROGRAMME FEE

Category	Programme Fee	
	M.Sc. (Course work)	**M.Sc. by (Course work & Research)**
Local candidates	Rs. 150,000/-	Rs. 275,000/-
Foreign candidates	Rs. 300,000/-	Rs. 550,000/-

Students registered for the M.Sc. degree by course work shall pay the Programme fee in full or in two *(1/2 at the registration and the balance at the end of the first semester)* or three *(1/3rd at the registration, another 1/3rd after 4 months from the date of registration and the balance after 8 months from the date of registration)* installments. An additional payment of Rs. 100,000/- (or Rs. 200,000/- form foreign students) should be made at the end of the first year to continue for the M.Sc. degree by course work & research. Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS. (N.B. The Programme fees given above may be revised as per recommendation of the Board of Management of the PGIS.)

5. THE PROGRAMME STRUCTURE AND DURATION

This programme consists of three options for completion.

5.1 Masters Degree with Course Work (SLQF Level 9)

The M.Sc. degree (Course work) can be obtained by completing course work only (without conducting any research project).

Course work, comprising of theory courses, and laboratory and/or fieldwork, shall be conducted over a period of two semesters of 15 weeks each. The total duration of the degree, including examinations, shall be about 12 months. Satisfactory completion of a minimum of 30 credits of course work with a GPA of not less than 3.00 is required for the successful completion of the degree - SLQF Level 9 (Students who do not satisfy the above criteria but obtain a GPA in the range 2.75 to 2.99 for course work of 25 credits are eligible for the Postgraduate Diploma in Nanoscience and Nanotechnology - SLQF Level 8, and those who obtain a GPA in the range 2.75 to 2.99 for course work of 20 credits are eligible for Postgraduate Certificate - SLQF Level 7).

5.2 Masters Degree (SLQF Level 10)

In addition to Masters Degree with course work (5.1), the Masters Degree (Research) requires a research project. The duration of the entire programme shall be 24 months inclusive of 5.1. Completion of all the requirements of 5.1 with a GPA of not less than 3.00 is a prerequisite for the Masters Degree (Research). The research project for this degree should be conducted on full-time basis, and completed during the second year. The research component is allocated 30 credits, totalling 60 credits for the entire programme. After successful completion of the research project, the student shall be eligible for the award of the M.Sc. Degree in Nanoscience and Nanotechnology - SLQF Level 10 (Students who do not complete the research project within the stipulated time period shall be awarded the M.Sc. Degree in course work in Nanoscience and Nanotechnology - SLQF Level 9).

5.3 Extension of the programme for M.Phil. (SLQF Level 11) or Ph.D. (SLQF Level 12)

After conducting research for a period of six months in the M.Sc. degree (research) programme, students who have demonstrated exceptional progress may apply for upgrading the degree status to M.Phil. The student should continue the research project and any additional research work/assignments recommended by the PGIS for a total of two years (60 credits of research) to qualify for the award of the M.Phil. degree (SLQF Level 11).

During the second year of research, students who have demonstrated exceptional and continuous progress may apply for upgrading the degree status from M.Phil. to Ph.D. The student should continue the research project and any additional research work/assignments recommended by the PGIS for another year on full-time basis (additional 30 credits) to qualify for the award of the Ph.D. degree (SLQF Level 12).

Programme Summary

Course Code	Course	Lecture hrs.	Practical hrs.	No. of Credits
Semester I				
CHN 501	Introduction to Nanoscience and Nanotechnology	15		1
PHN 502	Basic Physics for Nanoscience and Nanotechnology	30		2
CHN 503	Nanochemistry	30		2
CHN 522	Characterization Techniques for Nanomaterials	30		2
CHN 505	Biochemistry related to Nanoscience and Nanotechnology	15		1
PHN 506	Carbon Nanotubes and Particles	15		1
CHN 507	Nanoscience and Nanotechnology Laboratory I		90	3
CHN 597	Scientific Writing, Research Methodology and Seminar	15		1
PHN 516	Applications of Nanomaterials in Local Industries	30		2
Semester II				
PHN 517	Nanotechnology in Energy Conversion and Storage*	45		3
PHN 518	Nanoelectronic Devices*	30		2
CHN 519	Nanobiotechnology and Nanotechnology in Healthcare*	45		3

CHN 520	Business Enterprise, Economics and Research Policy in Nanotechnology*	30		2
CHN 521	Environmental Nanotechnology*	30		2
CHN 508	Nanoscience and Nanotechnology Laboratory II		60	2
CHN 599	Independent Study I**[1]	500 notional hrs.		5
CHN 699	Research Project**[2]	3000 notional hrs. (one year duration)		30

* Optional courses. Students are required to obtain 8 credits from optional courses (No. of Credits offered: Compulsory Courses = 16, Optional Courses = 12, Research Project = 06).
**[1] *Compulsory for M.Sc. (Course work)*
**[2] *Compulsory for M.Sc. (Research)*

6. PROGRAMME CONTENTS OF CHN 522, CHN 599 AND CHN 699

Course code	CHN 522
Course title	Characterization Techniques for Nanomaterials
Credits	2
Compulsory/optional	Compulsory
Prerequisites	CHN 501
Time allocation	30 Lecture hrs.
Aims	To develop understanding on the theoretical background of characterization techniques for nanomaterials
Intended learning outcomes	At the end of the successful completion of the course, students will be able to explain the use and theoretical mechanism of 1. Microscopies: optical microscopy, fluorescence and confocal microscopy, TEM, SEM, 2. Probe techniques: Scanning tunneling microscopy (STM), Atomic force microscopy (AFM), Scanning Nearfield Optical Microscopy SNOM, Scanning Ion Conducting Microscopy (SICM). Ellipsometry, Neutron Scattering and XRD 3. Spectroscopic Techniques: UV-visible, FT-IR, Raman, NMR, ESR. 4. Electrochemical Techniques: Voltammetric techniques, AC Impedance Analysis
Content	Characterization Techniques Related to Nanoscience and Nanotechnology: Compositional surface analysis: XPS, SIMS, Contact angles. Microscopies: optical microscopy, fluorescence and confocal microscopy, TEM, SEM, Probe techniques: Scanning tunneling microscopy (STM), Atomic force microscopy (AFM), Scanning Nearfield Optical Microscopy SNOM, Scanning Ion Conducting Microscopy (SICM). Ellipsometry, Neutron Scattering and XRD, Spectroscopic Techniques: UV-visible, FT-IR, Raman, NMR, ESR. Electrochemical Techniques: Voltammetric techniques, AC Impedance Analysis

Assessment criteria

Continuous assessment	End-semester examination
30%	70%

References:-

West Anthony, Solid State Chemistry and its Applications, 2nd Edition, John Wiley & Sons, 1987, USA

Course code	CHN 599
Course title	Independent Study
Credits	05
Compulsory/optional	Compulsory
Prerequisites	CH 501, which can be taken concurrently
Time allocation	500 notional hrs.
Aims	Aims: The overall aim is to familiarize the student with concepts and methods involved in scientific research **Specific aims:** 1. To explain the scientific process in the conduct of research. 2. To develop skills to write a review paper and a scientific research proposal. 3. To develop skills to make a presentation. 4. To master the application of statistical methods on quantitative scientific data.
Intended learning outcomes	At the end of the successful completion of the course, students will be able to, 1. Explain the scientific method. 2. Conduct an independent review of literature on a selected topic in the area of Analytical Chemistry. 3. Write a formal scientific report conforming to the guidelines provided. 4. Transfer the knowledge gained through (2) and (3) above in the form of a presentation. 5. Complete a research proposal conforming to the guidelines provided. 6. Perform statistical analysis of quantitative data.
Content	*Review paper*: Review of literature; Development of the review paper in concise and professional manner and logical presentation of results that have been reported, writing the abstract, compilation of the list of references. *Proposal writing*: Interpretation and critical evaluation of results of published research; Formulation of a research problem: Concise literature review, justification, time frame, identification of resources, budgeting, etc. *Project*: Collection and statistical analysis of data on a topic associated with the review paper. *Seminar*: Presentation of literature and data collected on a given topic; Preparation of an abstract, preparation of slides.

Assessment criteria: Continuous Assessment

Component	% marks

Review paper	20
Proposal writing	10
Project	40
Seminar	30

Recommended Texts:

1. Backwell, J., Martin, J. (2011) A Scientific Approach to Scientific Writing, Springer.
2. Postgraduate Institute of Science (2016) Guidelines for Writing M.Sc. Project Report/M.Phil. Thesis/Ph.D. Thesis
3. Priyantha, N (2015) Measurements and Errors in Chemical Analysis, Science Education Unit, University of Peradeniya.

Course code	CHN 699
Course title	Research Project
Credits	30
Compulsory/optional	Compulsory
Prerequisites	CH 599; GPA of 3.00 at SLQF Exit Level 9
Time allocation	3000 notional hrs. (one year duration)
Aims	Aims: The overall aim is to prepare the student to conduct a research independently. **Specific aims:** 1. To train students to apply scientific method in scientific research. 2. To train students to generate researchable hypotheses. 3. To train students to plan, design and conduct scientific research. 4. To gather reliable scientific data, analyse, and interpret. 5. To develop skills in scientific writing.
Intended learning outcomes	At the end of the successful completion of the course, students will be able to, 1. Apply the scientific method. 2. Design a research project. 3. Complete a research project. 4. Describe ethical issues in scientific research. 5. Explain the patenting process in research. 6. Make presentations at national/international conferences. 7. Produce a thesis conforming to the requirements of the PGIS. 8. Write manuscripts for publication in refereed journals.
Content	The students will conduct sufficient amount of laboratory/field work on a chosen research topic under the guidance provided by an assigned supervisor/s, make a presentation of research findings at a national/international conference, and produce a thesis.

Assessment criteria

Continuous assessment	End-semester examination
30%	Oral examination (20%) Thesis (40%) Conference presentation (10%)

CONTENTS OF OTHER COURSES

CHN 501: Introduction to Nanoscience and Nanotechnology (1 Credit)

Nanotechnology Timeline and Milestones, Overview of different nanomaterials available, Potential uses of nanomaterials in electronics, robotics, computers, sensors in textiles, sports equipment, mobile electronic devices, vehicles and transportation. Medical applications of nanomaterials.

PHN 502: Basic Physics for Nanoscience and Nanotechnology (2 Credits)

Introduction to Quantum and Statistical Physics: Electrons as waves, wave mechanics, Schrödinger equation and particle in a box, Heisenberg's Uncertainty Principle, Introduction to the operator formalism-bas, kets, expectation values, Spin and exclusion principle, Boltzmann distribution, indistinguishable particles, Fermi-Dirac and Bose-Einstein distributions.
Introduction to Solid State Physics: Crystal structure: free electron theory of metals, band theory of solids, metals and insulators, Semiconductors: classification, electrons and holes, transport properties, size and dimensionality effects, Quantum size effects in semiconductor quantum dots and nanowires, The p-n junction and the bipolar transistor; metal-semiconductor and metal-insulator, Semiconductor junctions; field-effect transistors, MOSFETs, CMOS: heterostructures, high-electron-mobility devices, HEMTs, Quantum Hall effect, Introduction to single electron transistors (SETs): quantum dots, single electron effects, Coulomb blockade.
Introduction to magnetism and superconductivity: Basic Magnetic Phenomena; paramagnetism, ferromagnetism, ferrimagnetism, anti-ferromagnetism, neon-magnetism, grant and colossal magnetoresistance: ferrofluids, Basic superconductivity phenomena, flux quantization and Josephson effects.

CHN 503: Nanochemistry (2 Credits)

Novel physical chemistry related to nanoparticles such as colloids and clusters: different equilibrium structures, quantum effects, conductivity and enhanced catalytic activity compared to the same materials in the macroscopic state.
Exploitation of self-assembly and self-organization to design functional structures in 1D, 2D or 3D structures. Examples to emphasize on self-assembled monolayers.
Role of polymers in lithography resists, as well as self-organization of more complicated polymer architectures such as block copolymers and polymer brushes.
Nanomaterials (Nanoparticles, nanoclusters, quantum dots synthesis): Preparation and Characterization: "Top-Down" and "Bottom-Up" approaches of nanomaterial (nanoparticles, nanoclusters and quantum dots) synthesis: Top-down techniques: photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithographies, Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Pattern replication techniques: soft lithography, nanoimprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques (polymerization, directed assembly). Combination of Top-Down and Bottom-up techniques: current state-of-the-art.

CHN 505: Biochemistry related to Nanoscience and Nanotechnology (1 Credit)

Basic Aspects of Molecular Biology: Structure and function of proteins, antibodies, enzymes and implications for processing. Nucleic acids: DNA, RNA. Lipids: structure, role in membranes. The mammalian cell: Internal organization, specialized cells such as nerve cells. Building up of nano-structures that incorporate biological molecules as components of the system. Use of biological design strategies as removable scaffolds and templates for the bottom-up assembly of nanomaterials. Applications of nanotechnology in biotechnology: killing cancer cells, providing oxygen and artificial mitochondria.

PHN 506: Carbon Nanotubes and Particles (1 Credit)

Synthesis and purification of carbon nanotubes, Single-walled carbon nanotubes and multiwalled carbon nanotubes, Structure-property relationships, Physical properties, Applications.

CHN 507: Nanoscience and Nanotechnology Laboratory I (3 Credits)

Some selected experiments will be done from the list of experiments given below.

Synthesis of nanometre scale particles of colloidal semiconductors such as TiO_2, CdS, ZnO, SnO_2, Cu_2S, CuCNS, Cu_2O, $BaTiO_3$, $SrTiO_3$ by wet chemical methods, hydrothermal methods, and pyrolytic or high temperature methods.

Characterization of colloidal semiconductor materials by UV-visible spectroscopy, XRF studies, XRD methods and determination of particle size using XRD half peak width.

Determination of conductivity type by Mott-Shottky plots, cyclic voltammetry and AC-impedance analysis.

Deposition of thin films of semiconductor nanostructures by doctor blading, screen printing, and using the Langmuir-Blogett film casting techniques.

Dye sensitization of semiconductor nanosctructures and construction of solar cells.

Synthesis and characterization of nanoparticles of technologically valuable natural minerals such as hydroxyapatite, ferric phosphate, colloidal silica nanoparticles and their characterization by XRD, XRF, FT-IR methods.

Clay-polymer nanocomposites: Clay-ionically conducting polymer nanocomposites and determination of their ionic conductivities by AC impedance analysis, clay-electronically conducting polymer nanocomposites and determination of their electronic and ionic conductivities through AC impedance analysis and current-time plots at constant applied potential using blocking and non-blocking electrodes.

Synthesis of layered double hydroxides and investigation of anion separation using layered double hydroxides.

Pillard clays and clay-polystyrene, clay-poly(vinyl alcohol), clay-poly(methyl methacylate), clay-polyacylonitrile, clay-poly(ethylene oxide) nanocomposites and determination of their mechanical and thermal properties.

Covalent attachment of semiconductor nanoparticles into textile fibres and textile materials. Investigation of stain-resistant properties and antimicrobial activities.

Preparation of mosquito-repellent textiles.

Carbon nanotubes and carbon nanoparticles: Preparation of carbon nanotubes by pyrolysis of organic gases/Pyrolytic thermal treatment of graphite followed by annealing. Purification of carbon nanotubes, Investigation of extent of purification using XRD, SEM studies of carbon nanotubes (to be carried out elsewhere), Extraction of carbon nanoparticles from vehicle exhausts, Characterization and Particle size analysis using XRD.

Top-down approach to nanoparticles of local minerals: crushing, grinding and milling, Preparation of graphite nanoparticles.

Preparation of colloidal graphite nanoparticles and investigation of their technological uses as lubricants.
Preparation of self-assembled monolayers and their characterization using AFM, contact angle measurements, AC-impedance analysis.

CHN 508: Nanoscience and Nanotechnology Laboratory II (2 Credits)

Protein extraction and purification; Chromatographic techniques, SDS-PAGE, Protein quantification, DNA extraction from animal, plant and bacteria cells, Agarose and Gel electrophoresis.

CHN 597: Scientific Writing, Research Methodology and Seminar (1 Credit)

Compulsory for all students: Each student is required to present a seminar under the supervision of a staff member assigned by the course coordinator.

The nature and concepts of research, types of research and tools of research, research design and conceptualization, operationalization measurement and causality, survey of research and data collection techniques, strategies for data analysis and their applications, scientific and technical writing, writing research reports/thesis and scientific papers, compilation of bibliography, information gathering through internet and use of electronic resources.

PHN 516: Applications of Nanomaterials in Local Industries (2 Credits)

Applications of nanoscience and nanotechnology in Sri Lankan industries: Garment industry: Smart textiles with antimicrobial properities, stain-resistant properties, mosquito-repellent properties, nanosensors to detect body temperature, pressure, pulse rate, and so on. Rubber industry: Clay-rubber nanocomposites, carbon nanotube-rubber nanocomposites. Activated carbon industry: Applications of activated carbon nanostructures in supercapacitors, gas separation, catalysis. Local minerals for advanced industries: Graphite, ilmanite, quartz, mica, rutile, zircon, feldspars, gems etc. Electronics industry: Solar cells, electronic components, light-emitting diodes, liquid-crystal display devices, electronically conducting polymers, ionically conducting polymers, batteries, fuel cells.

PHN 517: Nanotechnology in Energy Conversion and Storage (3 Credits)

Improvements in solar energy conversion and storage; better energy-efficient lighting; stronger and lighter materials that will improve energy transportation efficiency; use of low-energy chemical pathways to break down toxic substances for remediation and restoration; and better sensors and controls to increase efficiency in manufacturing and processing.
Energy Storage: Fuel Cells, Carbon Nanotubes for energy storage, Hydrogen Storage in Carbon Nanotubes, Use of nanoscale catalysts to save energy and increase the productivity in industry, Rechargeable batteries based on nanomaterials.
Goals for the next 5-10 years – solutions and barriers in Nanotechnology and energy.

PHN 518: Nanoelectronic Devices (2 Credits)

Nanoscale electronic, optical, liquid crystal and magnetic devices, Spintronic devices including spin valves and MRAM devices, nanoscale semiconductor electronic devices including CMOS at sub-15 nm gate length, III-V and wide band gap devices, solid state devices for quantum computation including Josephson junctions and quantum dots, nanoscale photonic devices including photonic band gap materials. Nanoscale liquid crystal display and nondisplay devices, organic electronic devices.

CHN 519: Nanobiotechnology and Nanotechnology in Healthcare (3 Credits)

Doctor-Patient Interface: Testing Devices in the Doctor's Office. e.g. of blood and urine samples for Home / Ambulance / Bedside Monitoring.
Underpinning Electronic and Optical Techniques: Amperometric sensors, Potentiometric sensors including chemically sensitive field effect transistors, Optical sensors including evanescent field sensors and optical waveguide sensors, Surface Plasmon Resonance sensors, Resonant Mirror sensors, Capillary Fill Devices, Electro-mechanical Devices such as cantilever bridge sensors.
Underpinning Biological Techniques: Enzyme-based assays, Antibody-based assays, Nucleic acid-based techniques e.g., Polymerase chain reaction (PCR), Lab-on-a-chip.
Applications in the Pharmaceutical Industry: Adaptation of above techniques for large analyte panel testing e.g., Lab-on-a-chip in screening in drug development, Development of techniques for process control in pharmaceutical industry.
Applications in Medical Research Laboratories: Development of instrumentation for understanding bioprocesses.
Applications in the Hospital Environment: Implantation of large scale integrated circuits, e.g., to bypass lesion in paraplegia and provide muscle control, Nanotechnology in devising hybrid systems in which electronic and neural elements communicate. Novel nanoscale imaging agents at the research level.
Bionanomachines in action: Biomolecules; Structure and function of Proteins, Polysaccharides, Lipids, Nucleic acids; DNA and RNA.
Biomolecular design and Biotechnology: Recombinant DNA technology, Biomolecular structure determination, Molecular Modeling.
Structural principles of Bionanotechnology: The raw materials; biomolecular structure and stability, Protein folding, Self assembly, Self-organization, Molecular recognition, Flexibility
Functional principles of Bionanotechnology: Information driven nano-assembly, Energetics, Chemical transformation, Regulation, Biomaterials, Biomolecular motors, Traffic across membranes, Biomolecular sensing, Self replication, Machine-Phase bionanotechnology.
Bionanotechnology today: Basic capabilities, Nanomedicine, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors**.**
The future of Bionanotechnology: Ethical considerations, Case studies.

CHN 520: Business Enterprise, Economics and Research Policy in Nanotechnology (2 Credits)

Nanotechnology landscape and commercially attributable sectors, tools to map, understand and segment the nanotechnology marketplace, Frameworks for developing nanotechnology marketplace, management issues, Costing strategies, commercialization strategies, Intellectual Property Issues, Societal Impacts, Health and Safety Issues, Customer understanding, marketing, social and policy issues arising from the development of nanotechnology, ethics. Nanotechnology in sustainability and wealth of nations, organizations and entire industries in the future. How the nations prepare talent, intellectual property, capital and technical expertise to develop the petro-economy, healthcare products and power supply to the nation. Funding strategies/ Education policies in the world and Sri Lanka. Worldwide Research Activities. Tools and Nanoproduct Development. Present Global Nanotechnology efforts.

CHN 521: Environmental Nanotechnology (2 Credits)

Reduced waste and improved energy efficiency.
Waste remediation: Nanoporous polymers and their applications in water purification, Photo-catalytic fluid purification. Energy conversion. Hierarchical self-assembled nano-structures for adsorption of heavy metals. Pollution by Nano-particles.

7. PROGRAMME EVALUATION

Evaluation of Course work

Based on the scheme given below, the overall performance of a student in a given course shall be evaluated by the respective instructor(s) and a grade shall be assigned.

Evaluation Scheme

- For all courses a minimum of 80% attendance is expected.
- The evaluation of each course shall be based on within course and end of course examinations, and assignments. The weightage of marks given below can generally be used as a guideline in the computation of the final grade.

End of course examination	50 - 60%
Continuous assessments (mid-semester examination, assignments, etc.)	40 - 50%

- Courses with laboratory and/or fieldwork shall be evaluated, where applicable, on a continuous assessment basis.
- The minimum grade a student should achieve to pass a course is C.
- Students will be informed of the evaluation scheme by the instructor at the beginning of a given course.

Grade Points and Grade Point Average (GPA)

The Grade Point Average (GPA) will be computed using the grades earned for core courses and optional courses, taken for credit. Preliminary courses, industrial training, research project and seminar will be evaluated on a pass/fail basis.

On completion of the end of course examination, the instructor(s) is/are required to hand over the grades of a given course to the programme coordinator who will assign the Grade Points using the following table:

Grade	Grade Point
A+	4.0
A	4.0
A^-	3.7
B^+	3.3
B	3.0
B^-	2.7
C^+	2.3

C	2.0
F	0.0

The Grade Point Average (GPA) will be computed using the formula:

$$GPA = \frac{\Sigma c_i g_i}{\Sigma c_i},$$

where c_i = number of credit units for the i^{th} course, and
g_i = grade point for the i^{th} course

Make-up Examinations
'Make-up' examinations may be given only to students who fail to sit a particular examination due to medical or other valid reasons acceptable to the PGIS.

Repeat Courses
If a student fails a course or wishes to improve his/her previous grade in a course, he/she shall repeat the course and course examinations at the next available opportunity. However, he/she may be exempted from repeating the course, and repeat only the course examinations if recommended by the teacher-in-charge or M.Sc. Programme Coordinator. The student may repeat the same course or a substituted (new) optional course in place of the original course. A student is allowed to repeat five credits of coursework free-of-charge. The maximum number of credits a candidate is allowed to repeat is fifteen. The maximum grade, a candidate could obtain at a repeat attempt is a B and he/she is allowed to repeat a given course only on two subsequent occasions.

Evaluation of Research Project

Research project will be evaluated on the basis of a written report (M.Sc. project report) and oral presentation (see Section 6.0 of the PGIS Handbook for the format of the project report).

8. PANEL OF TEACHERS

Professor HMN Bandara, Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Aston)
Field of specialization – Nanotechnology and Instrumentation
Dr. LRAK Bandara, Department of Physics, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Perad.) [PHN 518]
Field of specialization – Material physics, Energy materials
Dr. ADHK Kankanamge, Department of Economics, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Oklahoma) [CHN 520]
Field of specialization – Economics
Professor BSB Karunaratne, Department of Physics, University of Peradeniya
B.Sc. (Cey.), Ph.D. (Warwick) [PHN 516]
Field of specialization – Ceramics, Material Science
Professor DN Karunaratne, Department of Chemistry, University of Peradeniya
B.Sc. (Col.), Ph.D. (Br. Col.) [CHN 505]
Field of specialization – Biochemistry
Professor HMDN Priyantha, Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Hawaii) [CHN 521]
Field of specialization – Physical Chemistry
Professor RMG Rajapakse, Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Lond.) [CHN 501, CHN 507, CHN 508, CHN 599]
Field of specialization – Nanotechnology, Nanochemistry

Dr. RGS Rajapakse, Department of Molecular Biology & Biotechnology, University of Peradeniya, *B.Sc. (Perad.), Ph.D. (Japan)* [CHN 508, CHN 519]
Field of specialization – Nanobiotechnology, molecular biology

Prof. K Premaratne, Department of Physics, University of Peradeniya
B.Sc. (Cey.), M.S., Ph.D. (Hawaii) [PHN 502, PHN 517]
Field of specialization – Nanophysics

Professor CP Udawatta, Department of Physical Sciences, Sabaragamuwa University of Sri Lanka
B.Sc. (Perad.), PhD (*Perad.*)
Field of specialization – Material Chemistry

Professor BMR Bandara, Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), Ph.D. (ANU)
Field of specialization – Organic Chemistry

Professor OA Ileperuma, Department of Chemistry, University of Peradeniya
B.Sc. (Cey.), Ph.D. (Arizona)
Field of specialization – Inorganic Chemistry, Solar Cells

Dr. AN Navaratne, Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Hawaii)
Field of specialization – Analytical Chemistry

Professor ADLC Perera, Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), Ph.D. (TIT)
Field of specialization – Physical Chemistry

Dr. VA Seneviratne, Department of Physics, University of Peradeniya
B.Sc. (Perad.), Ph.D. (Oklahoma)
Field of specialization – Carbon Nanotubes

Professor SAR Weerasuriya, Institute of Fundamental Studies, Hantana Road, Kandy.
B.Sc. (Perad.), Ph.D. (Sri Lanka)
Field of specialization – Environmental Nanotechnology

Dr. BS Dasanayake, Department of Physics, University of Peradeniya
B.Sc. (Perad.), PhD (*Western Michigan, USA*)
Field of specialization – Nanoscience, Material Physics

Dr. ACA Jayasundera, Department of Chemistry, University of Peradeniya
B.Sc. (USJP, Sri Lanka), MPhil (Cardiff, UK), Ph.D. (St Andrews, UK)
Field of specialization – Nanochemistry, Solid State Chemistry

Dr. MMMGPG Mantilaka, Sri Lanka Nanotechnology Institute
B.Sc. (Perad.), PhD (*Perad)*
Field of specialization – Nanoscience

Prof. SHPP Karunaratne, Department of Zoology, University of Peradeniya
B.Sc. (Perad.), PhD (*London, UK)*
Field of specialization – Nanobiotechnology and Nanotechnology in Healthcare

Dr. RJKU Ranatunga, Ph.D., Department of Chemistry, University of Peradeniya
B.Sc. (Perad.), PhD (*Texas, USA*)
Field of specialization – Computational Chemistry

Dr. HMAMC Herath, Faculty of Applied Sciences, Rajarata University of Sri Lanka,
B.Sc. (Grad. I.Chem.), PhD (*Perad.*)
Field of specialization – Environmental Nanotechnology

9. PROGRAMME COORDINATOR/S

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