2.2.2 Description of courses

Division of Chemistry and Biological Chemistry

CBC721 Graduate Analytical Chemistry
AUs: 4
Prerequisites: CBC421 Advanced Analytical and Bioanalytical Techniques. CBC426 Chemical Kinetics and Dynamics. Competence in mathematics (experience in solving partial differential equations and Laplace transforms) or Divisional approval.
Semester 1
This course presents the latest analytical techniques and those that are just emerging. It provides graduate students with the background for research in the field. Emphasis is on experimental techniques and the theory of electroanalytical chemistry.

CBC722 Graduate Inorganic Chemistry
AUs: 4
Prerequisites: CBC312 Organometallic Chemistry or Division approval
Semester 1
A spectrum of essential topics in inorganic chemistry that will be useful for all entry level graduate students will be covered. The topics include physical inorganic chemistry, synthetic methodologies and characterisation techniques. These topics will equip the graduate students with basic knowledge and skills that will enable them to function more effectively in a modern inorganic research environment, and they also form the background knowledge for the more specialised inorganic elective modules.

CBC723 Graduate Organic Chemistry
AUs: 4
Prerequisites: CBC313 Organic Reaction Mechanisms and Synthesis or Division approval
Semester 1
Advanced topics in organic synthesis, including major synthetically useful reactions, with an emphasis on asymmetric processes. Metal-mediated organic transformations. Protecting groups in organic synthesis. Selected mechanisms in organic synthesis.

CBC724 Graduate Physical Chemistry
AUs: 4
Prerequisites: CBC314 Physical and Biophysical Chemistry 2 or Division approval
Semester 2
A broad sweep of the molecular approach to physical chemistry required for research. The core theories of physical chemistry in greater breadth and depth: Quantum theory and spectroscopy, Statistical and equilibrium thermodynamics, and Chemical kinetics and dynamics. Special advanced topics in modern physical chemistry will also be presented.

CBC725 Contemporary Organometallic Chemistry
AUs: 4
Prerequisites: CBC312 Organometallic Chemistry or Division approval
Semester 2
Principles and applications of organometallic compounds: synthesis, reactivity and structural aspects.

CBC726 Advanced Organic Chemistry
AUs: 4
Prerequisites: CBC313 Organic Reaction Mechanisms and Synthesis or Division approval
Semester 2
Biomimetic reactions, the application of organometallics to organic synthesis, synthesis of complex molecules, and other emerging areas in organic synthesis. Students will be required to write a proposal and a review of a topic related to organic synthesis.

CBC729 Graduate Seminar Module (1)
AUs: 4
Prerequisites: Division approval
Semester 1
Comprise of three components:

• attend at least 14 seminars of which at least six are given by visitors or staff members and at least six are from CBC529 Graduate Student Symposium, e.g. 6+8, 7+7, etc
• deliver a 30 to 40-minute talk at the Graduate Student Symposium
• Questions and answers on a specified topic (taken from papers published in the past three years either in organic, inorganic, bio-organic and bio-inorganic related journals)

CBC730 Graduate Seminar Module (2)
AUs: 4
Prerequisites: Division approval
Semester 2
Comprise of three components:
• attend at least 14 seminars of which at least six are given by visitors or staff members and at least six are from CBC530 Graduate Student Symposium, e.g. 6+8, 7+7, etc
• deliver a 30 to 40-minute talk at the Graduate Student Symposium
• Questions and answers on a specified topic (taken from papers published in the past three years either in the area of physical, analytical, biophysical and bioanalytical related journals)

CBC732 Graduate Chemical Biology
AUs: 4
Prerequisites: Division approval
Semester 1
The course will present topics in modern chemical biology: proteins, nucleic acids, carbohydrate structure, enzyme catalysis and inhibition, metabolism, signal transduction, cancer and virus biology, molecular biology, transcription and translation, protein folding and selected topics of current interest taken from the literature.

CBC733 Advanced Computational Chemistry
AUs: 4
Prerequisites: Division approval
Semester 2
How to choose and how to use appropriate computer programs to study reaction mechanisms, catalysis, transport phenomena, organic and biorganic binding, device simulations and molecular conformation. Students will be required to complete a computational project in discussion with the module lecturer and their research advisor to obtain hands-on experience.

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Division of Mathematical Sciences

MAS710 Continuous Methods
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 2
Abstract integration (basic topology, general Lebesgue-like integrals and measures), positive Borel measures (Riesz representation theorem for positive linear functionals), Lpspaces, integration on product spaces, abstract differentiation, holomorphic functions.

MAS 711 Discrete Methods
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 2
Enumeration, graph and network algorithms, finite fields and applications, Boolean algebras, polyhedra and Linear Programming, algorithmic complexity.

MAS712 Algebraic Methods
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Groups, rings, fields, modules, basic techniques of Group Theory, Galois Theory.

MAS 713 Mathematical Statistics
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Review of probability, random variables and their distributions, moments and inequalities; point estimation in parametric setting; point estimation in nonparametric setting; interval estimation and hypothesis test.

MAS720 Topics in Discrete Mathematics I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Discrete Mathematics will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Combinatorics, Coding Theory, Cryptography, Network Algorithms, Bioinformatics

MAS721 Topics in Scientific Computation I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Scientific Computation will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Functional Analysis, Partial Differential Equations, Computational Fluid Dynamics, Computational Biology.

MAS722 Topics in Pure Mathematics I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Pure Mathematics will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Commutative Algebra, Topology, Differential Geometry, Mathematical Logic, Functional Analysis.

MAS 723 Topics in Probability and Statistics I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Statistics will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Survival Analysis Theory and Method, Computational Statistics, Time Series Analysis, Statistical Learning etc.

MAS 725 Topics in Discrete Mathematics II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Discrete Mathematics will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Combinatorics, Coding Theory, Cryptography, Network Algorithms, Bioinformatics.

MAS 726 Topics in Scientific Computation II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Scientific Computation will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Functional Analysis, Partial Differential Equations, Computational Fluid Dynamics, Computational Biology.

MAS 727 Topics in Pure Mathematics II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1

Topics in Pure Mathematics will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Commutative Algebra, Topology, Differential Geometry, Mathematical Logic, Functional Analysis.

MAS 728 Topics in Probability and Statistics II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics in Statistics will be covered to provide background knowledge necessary to conduct independent research in the area, e.g. topics from Survival Analysis Theory and Method, Computational Statistics, Time Series Analysis, Statistical Learning etc.

MAS730 Special Topics – Image Analysis
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1

- Differential Geometry of Curves and Surfaces
- Calculus of Variations
- Level Sets and Curve Evolutions
- Edge Preserving Smoothing of Curves and Surfaces
- Edge and Corner Detection
- Edge Integration and Segmentation
- Planar Shape Description and Analysis
- Invariant Recognition of Planar Shapes
- Shape from Shading and Photometric Stereo
- Depth from Stereo and Epipolar Geometry
- Optic Flow and Shape from Motion
- Grid Geometry and Numerics
- Fun Topics: Autostereograms, Space Fiducials, Visual Navigation

MAS790 Graduate Seminar – Discrete Mathematics I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics will be chosen to cover new developments in research in Discrete Mathematics and according to the interests of students.

MAS791 Graduate Seminar – Discrete Mathematics II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 2
Topics will be chosen to cover new developments in research in Discrete Mathematics and according to the interests of students.

MAS792 Graduate Seminar – Scientific Computation I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics will be chosen to cover new developments in research in Scientific Computation and according to the interests of students.

MAS793 Graduate Seminar – Scientific Computation II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 2
Topics will be chosen to cover new developments in research in Scientific Computation and according to the interests of students.

MAS794 Graduate Seminar – Pure Mathematics I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics will be chosen to cover new developments in research in Pure Mathematics and according to the interests of students.

MAS795 Graduate Seminar – Pure Mathematics II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 2
Topics will be chosen to cover new developments in research in Pure Mathematics and according to the interests of students.

MAS 796 Graduate Seminar – Statistics I
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 1
Topics will be chosen to cover new developments in research in Statistics and according to the interests of students.

MAS 797 Graduate Seminar – Statistics II
AUs: 4
Approval by the Division of Mathematical Sciences
Semester 2
Topics will be chosen to cover new developments in research in Statistics and according to the interests of students.

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Division of Physics and Applied Physics

PAP701 Graduate Seminar Module I
AUs: 4
Prerequisites: Division approval
Semester 1
To enable our research students to keep abreast with recent frontier research findings published in leading research journals, and in the ability to interact and communicate one-to-one or with a large group of people. In addition, students are expected to participate actively in discussions and address challenges/ questions with confidence. This module involves attending seminars organised by the Division and presented by experts in different fields. Students will also attend presentations by their peers. Students are required to give presentations as well as participate in discussions. They will also write critiques on the seminars they have attended.

PAP711 Graduate Solid State Physics
AUs: 4
Prerequisites: PAP442 Advanced Solid State Physics, or Division approval
Semester 2
Crystal structure, reciprocal lattice, Brillouin zones; structure determination by diffraction methods; kinematic and dynamical scattering. Phonons - dispersion, anharmonicity, thermal properties, structural phase changes, soft modes. Electrons - periodic potential, band gaps, dispersion, effective mass, Fermi surfaces, semiconductors, transport properties in metals and semiconductors, Landau quantisation, low- dimensional structures. Optical properties - interband transitions, excitons, plasmons, infrared absorption/reflectivity, Raman scattering, nonlineareffects. Magnetism - crystal field theory, magnetic ordering and phase transition, low-dimensional magnetism, spin waves, magnetic resonance, critical phenomena, domains. Superconductivity, - conventional, organic, high Tc; thermodynamics, London and BCS theories, Josephson effects.

PAP712 Computer Simulations in Physical Sciences
AUs: 4

Prerequisites: PAP311 Quantum Mechanics and PAP321 Statistical Mechanics, or Division approval
Semester 1
Basic Monte Carlo and molecular dynamics methods. Data and error analysis. Various advanced topics focusing on applications (First principle methods, advanced Monte Carlo and molecular dynamics topics, and modelling complex systems).

PAP713 Statistical Mechanic of Protein Folding
AUs: 4
Prerequisites: PAP 321 Statistical Mechanics or PAP 510 Concepts in Statistical mechanics
Semester 1
This module introduces an approach to protein folding from the point of view of kinetic theory. It includes standard topics such as thermodynamics, the Maxwell–Boltzmann distribution, and ensemble theory. Special discussions include the dynamics of phase transitions, and Brownian motion as an illustration of stochastic processes. Topics in molecular biology and protein structure, with a view to discovering mechanisms underlying protein folding are covered.

PAP714 Frontiers of Modern Physics
AUs: 4
Prerequisites: Division approval
Semester 1
This graduate module is designed as an introduction to the frontiers of modern physics, spanning from the nano to the cosmic. As physics has developed over many new fronts, and specialization sets in ever earlier in the life of a physicist, there is a need to develop the ability to look beyond the turf and appreciate the unity of physics. The course takes each topic and develops it using a basic knowledge of the physics principles involved.

PAP715 Materials Physics
AUs: 3
Prerequisites: PAP442 Solid State Physics II or Division approval
Semester 1
Students will learn the basic skills to establish the quantitative models based on modern thermodynamics; From the successful energy approaches, they will learn to understand many related experimental observations; They should also master the basic mathematical knowledge to solve the general nonlinear problems.

PAP719 Graduate Seminar Module II
AUs: 4
Prerequisites: Divisional approval
Semester 2
This course will expose the students to the recent frontier research findings published in leading research journals and enable them to study in depth some of this work while keeping abreast with current literature. Students will also be equipped with essential communication skills which enable them to express their idea clearly and to evaluate the research of other scientists critically. In addition, they are expected to be able to participate actively in discussions and address challenges with confidence. This module involves attending seminars organised by the Department and presented by experts in different fields. Students will also attend presentations by fellow graduate students. Students are required to give presentations as well as participate in discussions. They will also write critiques on the seminars they have attended. Towards the end of the module, a graduate student research congress will be organised for all graduate students to present their research work.

PAP721 Nonlinear Dynamics
AUs: 4
Prerequisites: PAP 352 Chaotic Dynamical Systems and PAP 441 Advanced Quantum Physics, or Division approval
Semester 2
This module provides students with the concepts and theories on nonlinear dynamical systems both in the classical and the quantum domains. Through this course, the student will come to appreciate the beautiful parallels between methods in nonlinear dynamics and thermodynamics; and gain a new perspective on quantum mechanics by studying quantum systems that correspond to classically chaotic systems.

PAP732 Nonlinear Optics
AUs: 4
Prerequisites: PAP362 Photonics and PAP462 Quantum Electronics, or Division approval
Semester 2
The course aims to provide a comprehensive understanding on the principles of nonlinear optics and is targeted at postgraduate students who have acquired a background in optics. The main content of the module introduces the principles of nonlinear optics and photonics devices used in modern optical communications, covered in four parts: Nonlinear optical susceptibility; Second-order nonlinear effects; Third-order nonlinear effects; Ultrafast laser optics.

PAP733 Elements of Modern Biophysics
AUs: 4
Prerequisites: PAP363 Biophysics or Division approval
Semester 1
Diffusion - random walk of colloids and biopolymers, diffusionin potential well, motor proteins, propulsion at low Reynoldsnumbers. Membranes - Langmuir monolayers, lipid bilayers, excitablemembranes, nerve signals. Fluorescence -fluorescence microscopy, Fluorescence Resonance Energy Transfer (FRET), labeling lipids andbiopolymers, applications to biomembranes. Optical particle tracking - basic theory, tracking colloids, fluorophores, motor proteins. Optical tweezers - basic theory, angular momentum, time-resolved and statistical methods, applications. Magnetic tweezers - basic theory, statistical methods, applications.

PAP739 Topics in Applied Physics
AUs: 4
Prerequisites: Divisional approval
Semester 2
This course introduces students to specialised topics in Applied Physics which are of current interest in research and development. Topics are chosen from various areas of Applied Physics including spectroscopy and modern devices. Students will be informed of the topic selected before the start of the semester.

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