Academic Programs Booklet

College of Science

2025

Prepared By: VP For Academic Programs and Graduate Studies Office

College of Science

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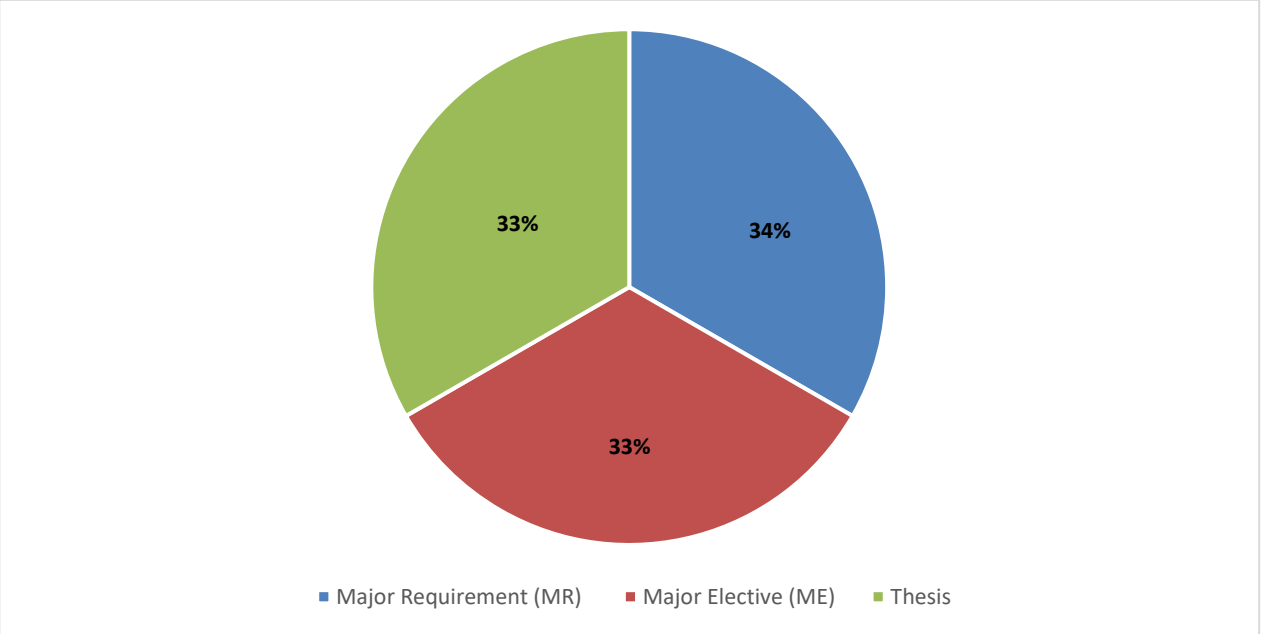
Master of Science in Physics

Program Components



Major Requirements (MR)	**12**
Major Electives (ME)[1]	**12**
Thesis	**12**
Total Credit (CRD)	**36**

[1] Student must select three courses from Major Electives (ME) List.

Detailed Study Plan

Year 1 - Semester 1

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS601	Research Methods in Physics	4	0	4	MR	------	Yes
PHYCS602	Methods of theoretical and computational Physics	4	0	4	MR	------	Yes
PHYCS603	Experimental Techniques in Physics	2	3	4	MR	------	Yes

Year 1 - Semester 2

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS6xx	Elective 1	X	X	4	ME	------	Yes
PHYCS6xx	Elective 2	X	X	4	ME	------	Yes
PHYCS6xx	Elective 3	X	X	4	ME	------	Yes

Year 2 – Semester 3

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 699	Thesis	0	36	12	Thesis	Completion of 20 CH	No

Major Elective Courses

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
622	Particle Physics	4	0	4	ME	-	YES
623	Detectors Technology	4	0	4	ME	-	YES
624	Accelerator Principles and techniques	4	0	4	ME	-	YES
651	Solid State Physics	4	0	4	ME	-	YES
652	Computational Material Science	4	0	4	ME	-	YES
653	Semiconductor Physics	4	0	4	ME	-	YES
656	Nanoscience and Nanomaterials	4	0	4	ME	-	YES
633	Nonlinear Optics	4	0	4	ME	-	YES
632	Quantum Optics	4	0	4	ME	-	YES
636	Laser Physics	4	0	4	ME	-	YES
661	Environmental Physics	4	0	4	ME	-	YES
665	Global warming and Climate change	4	0	4	ME	-	YES
692	Advanced Selected Topics in Physics	4	0	4	ME	-	YES

Course Description

Course Code: PHYCS 601 **Course Title: Research Methods in Physics** **(4-0-4)**
This course aims to provide students with the methods used by physics researchers in their research. This includes data collection, data processing, data analysis, project management, literature review, research ethics, scientific writing and presentation skills.

Course Code: PHYCS 602 **Course Title: Methods of theoretical and computational Physics (4-0-4)**
The course contains some advanced topics in theoretical and computational physics including Analytical and numerical solutions to partial differential equations. Green function method. Monte Carlo Simulations. Quantum Monte Carlo Simulations. Analytical and numerical solutions to eigenvalue problems. Symmetry groups. Special functions and their numerical evaluation.

Course Code: PHYCS 603 **Course Title: Experimental Techniques in Physics (2-4-4)**
Advanced experiments in different areas of physics including Hall effect, low temperature conductivity measurements; X-ray diffraction; preparation of thin films; photoluminescence of semiconductors; critical temperature in superconductors; optical and electrical characterization of solids; characterization of magnetic materials; laser oscillators; Gaussian beam measurements; nonlinear susceptibility.

Course Code: PHYCS 622 **Course Title: Particle Physics** **(4-0-4)**
This course provides an in-depth exploration of Particle Physics. The topics covered include Symmetries and Quarks; Antiparticles; Electrodynamics of Spinless Particles; The Dirac Equation; The Structure of Hadrons; Partons; Quantum Chromodynamics; Gauge Symmetries; The Weinberg-Salam Model and Beyond.

Course Code: PHYCS 623 **Course Title: Detectors Technology** **(4-0-4)**
This course covers the effects caused by charged or neutral particles traversing material and how these effects can be used to build detectors for particle physics experiments; discussion of the different types of detectors such as calorimeters, tracking detectors, scintillators, detectors to identify particles; examples of high energy physics and related field present and future experiments, including trigger and reasdout; applications of these detectors techniques in other areas such as medical science.

Course Code: PHYCS 624 **Course Title: Accelerator principles and techniques** **(4-0-4)**
This course provides an in-depth exploration of the fundamental applications of accelerators. Principles of present particle accelerators are covered. A detailed discussion of several examples of present accelerators, such as the LHC, and possible future projects such as the FCC and muon colliders. Discussion on new accelerator techniques such as wake field acceleration, which are presently R&D projects.

Course Code: PHYCS 632 **Course Title: Quantum Optics** **(4-0-4)**
This course provides advanced topics in quantum optics, including Planck's radiation law and the Einstein coefficients; quantum mechanics of the atom-radiation interaction; fluctuation properties of chaotic light, the quantized radiation field; interaction of quantized fields with atoms, photon optics; generation and amplification of light; resonance fluorescence and light scattering, nonlinear optics.

Course Code: PHYCS 633 **Course Title: Nonlinear Optics** **(4-0-4)**
Origin of optical nonlinearities; survey of nonlinear effects; the response function; density matrix formalism; resonant nonlinearities; wave propagation and processes in nonlinear media; dynamic optical nonlinearities in semiconductors; theory of solitons.

Course Code: PHYCS 636 **Course Title: Laser Physics** **(4-0-4)**
This course provides advanced topics in laser physics, including operation; Gaussian beams; optical resonators; interaction of radiation with matter, laser oscillation and amplification; laser excitation; gas discharge phenomena; transition rates; spectroscopy of common lasers; detection of optical radiation; application of lasers.

Course Code: PHYCS 651 **Course Title: SOLID STATE PHYSICS** **(4-0-4)**
This course provides advanced topics in solid state physics, including lattice dynamics in three dimensions; specific heat capacity; electron-phonon interaction; electrons in a periodic potential; Block's theorem; nearly free electron theory; band structure and Fermi surfaces; tight binding model; electron dynamics without relaxation; mechanism of relaxation and Boltzmann equation; relaxation time approximation; impurity scattering; electrical and thermal conductivity; thermoelectric effects; magnetoresistance.

Course Code: PHYCS 652 **Course Title: Computational Material Science** **(4-0-4)**
This course covers different techniques used in materials simulations including molecular dynamics, monte-carlo simulations, density functional theory, phase field models and finite element method.

Course Code: PHYCS 653 **Course Title: Semiconductor Physics** **(4-0-4)**
This course provides an in-depth exploration of the fundamental physical theories underlying semiconductor materials and devices. The topics cover: Band Structure, Charge Carrier Concentrations and Transport Phenomena, Non-Equilibrium in Semiconductors, Key Parameters of Semiconductor Materials and Semiconductor Components, such as the pn junctions, metal-semiconductor junctions, transistors, and solar cells.

Course Code: PHYCS 656 **Course Title: Nanoscience and Nanomaterials** **(4-0-4)**
This course provides an in-depth exploration of the nanoworld, including synthesis of nanomaterials; characterization techniques; thermal, optical, magnetic, electronic and mechanical properties of nanomaterials; processing of nanomaterials; emerging applications such as catalysis, electrochemistry, renewable energy and biomaterials; nanocomposites; recent advances in nanoscience and nanomaterials.

Course Code: PHYCS 661 **Course Title: Environmental Physics** **(4-0-4)**
This course provides advanced topics in Environmental Physics including forces of nature; energy transport; heat and radiation; biological effects of ionizing and non-ionizing radiation; atmospheric transport of pollutants, natural disasters; climate change; noise pollution; radioactivity, waste management; remote sensing and radiometry.

Course Code: PHYCS 665 **Course Title: Global warming and Climate change** **(4-0-4)**
This course pvodies advanced topics in global warming and climate change including the greenhouse effect; impacts of global warming; the rapid changes in global temperature; extreme weather patterns; the super-storms; impacts on global warming on ecosystems; greenhouse gases; global climate models; predicting future climates; impact of climate change on health.

Course Code: PHYCS 692 **Course Title: Advanced Selected Topics in Physics** **(4-0-4)**
This course provides an in-depth study of a certain advanced topic in an active research area in physics. The topic is chosen as per Department approval.

Course Code: PHYCS 699 **Course Title: Thesis** **(0-36-12)**
The student must conduct a research project in a specified and approved topic in one of the offered streams in physics. The research project will be supervised by a faculty member(s) and the student must submit and defend a thesis.