Academic Programs Booklet

College of Science

2018

Prepared By: VP For Academic Programs and Graduate Studies Office

College of Science

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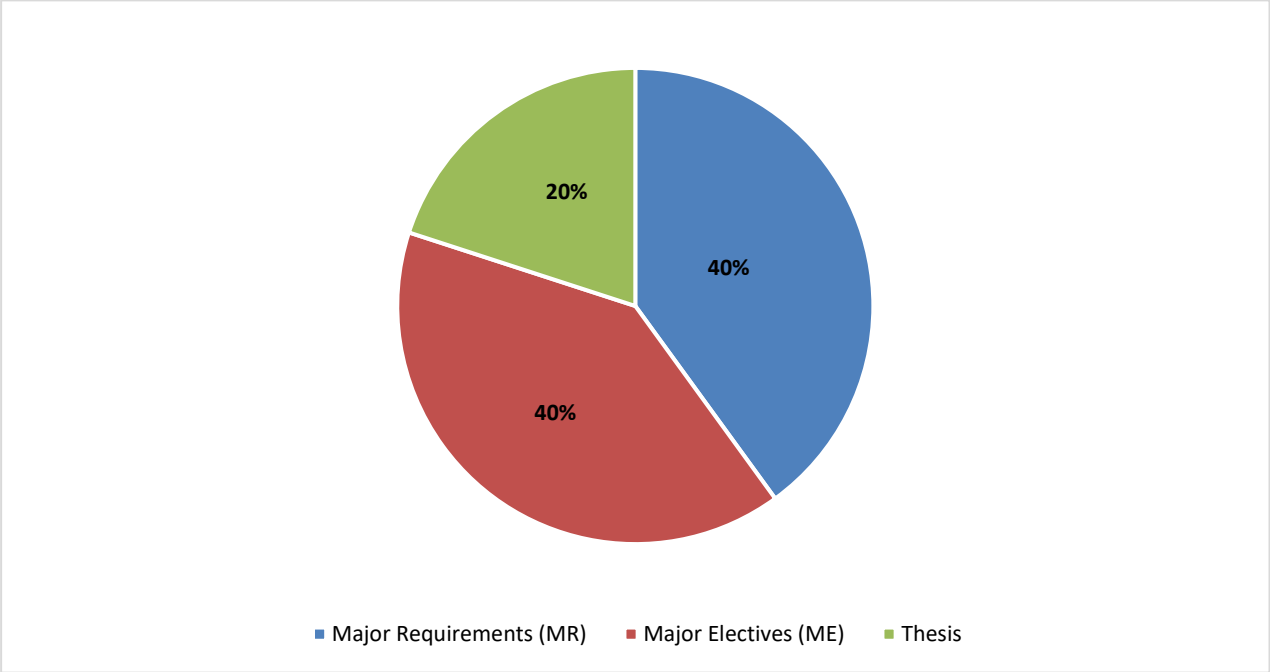
M.Sc. in Applied Physics

Program Components



Major Requirements (MR)	**12**
Major Electives (ME)[1]	**12**
Thesis	**6**
Total Credit (CRD)	**30**

[1] Student must select one course from the “advanced Skills” list and three courses from one of the streams.

Detailed Study Plan

Year 1 - Semester 1

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 511	Classical Mechanics	3	0	3	MR	------	Yes
PHYCS 526	Quantum Mechanics	3	0	3	MR	------	Yes
PHYCS 541	Classical Electrodynamics	3	0	3	MR	------	Yes

Year 1 - Semester 2

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 560	Thermal and Statistics Physics	3	0	3	MR	------	Yes
PHYCS ***	Elective Course	3	0	3	ME	------	Yes
PHYCS ***	Elective Course	3	0	3	ME	------	Yes

Year 2 – Semester 3

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS ***	Elective Course	3	0	3	ME	------	Yes
PHYCS ***	Elective Course	3	0	3	ME	------	Yes
PHYCS 598	Thesis	0	18	6	Thesis	Department Approval	No

Year 2 – Semester 4

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 598	Thesis	0	0	0	Thesis	Department Approval	No

Major Elective Courses

Advanced Skills

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 521	Methods of Theoretical Physics	3	0	3	ME	-----	Yes
PHYCS 529	Computational Physics	3	0	3	ME	-----	Yes
PHYCS 591	Experimental Techniques in Applied Physics	2	3	3	ME	-----	Yes

Stream1: Nanotechnology and Applied Condensed Matter Physics

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 551	Solid State Physics	3	0	3	ME	-----	Yes
PHYCS 552	Solid State Devices	3	0	3	ME	-----	Yes
PHYCS 553	Semiconductors	3	0	3	ME	-----	Yes
PHYCS 554	Materials Science	3	0	3	ME	-----	Yes
PHYCS 555	Physics of Non-Crystalline Solids	3	0	3	ME	-----	Yes
PHYCS 556	Nanoscience & Nanomaterials	3	0	3	ME	-----	Yes
PHYCS 557	Nanotechnology	3	0	3	ME	-----	Yes
PHYCS 558	Selected Topics in Condensed Matter Physics	3	0	3	ME	-----	Yes

Stream 2: Applied Photonics

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 531	Applied Optics	3	0	3	ME	-----	Yes
PHYCS 532	Quantum Optics	3	0	3	ME	-----	Yes
PHYCS 533	Nonlinear Optics	3	0	3	ME	-----	Yes
PHYCS 534	Optoelectronics	3	0	3	ME	-----	Yes
PHYCS 535	Atomic and Molecular Spectroscopy	3	0	3	ME	-----	Yes
PHYCS 536	Laser Physics	3	0	3	ME	-----	Yes

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 537	Photophysics	3	0	3	ME	-----	Yes
PHYCS 538	Selected Topics in Applied Photonics	3	0	3	ME	-----	Yes

Stream 3 Applied Environmental Physics

Course Code	Course Title	Course Hours			Course Type	Pre requisite	Major GPA
		LEC	PRAC	CRD			
PHYCS 561	Environmental Physics	3	0	3	ME	-----	Yes
PHYCS 562	Physics of Arid Areas	3	0	3	ME	-----	Yes
PHYCS 563	Global Warming and Climate Change	3	0	3	ME	-----	Yes
PHYCS 564	Advanced Earth Science	3	0	3	ME	-----	Yes
PHYCS 565	Physics of Building Environment	3	0	3	ME	-----	Yes
PHYCS 566	Atmospheric Physics	3	0	3	ME	-----	Yes
PHYCS 567	Renewable Energy Resources and Technology	3	0	3	ME	-----	Yes
PHYCS 568	Selected Topics in Environmental Physics	3	0	3	ME	-----	Yes

Course Description

Course Code: PHYCS 511 **Course Title: CLASSICAL MECHANICS** **(3-0-3)**
Review of basic principles of Newtonian Mechanics; dynamics of a system of particles; moving coordinate systems; tensor algebra; inertia and stress tensors; rotation of rigid bodies; Hamilton's equation; canonical transformation; Hamilton-Jacobi equation; theory of small oscillations; relativistic dynamics.

Course Code: PHYCS 521 **Course Title: METHODS OF THEORETICAL PHYSICS** **(3-0-3)**
Vector spaces; operators; tensor algebra; algebraic eigenvalue problem; special functions; Green's function and its applications; integral equations in Hilbert space; elements of group theory; symmetry groups and group representations; some applications in condensed matter and high energy particle physics; statistical distribution functions.

Course Code: PHYCS 526 **Course Title: QUANTUM MECHANICS** **(3-0-3)**
Quantum mechanics in Hilbert space; observables and operators; angular momentum and intrinsic spin in Hilbert space; Clebsh-Gordon coefficients; spin-orbit interactions and interactions with external fields; quantum theory of scattering by a potential; Green's function solutions of local and non-local separable potential scattering problems; stationary perturbation theory; time dependent perturbation theory; the fine and hyperfine structure of the hydrogen and helium atoms; relativistic quantum mechanics.

Course Code: PHYCS 529 **Course Title: COMPUTATIONAL PHYSICS** **(3-0-3)**
Methods of implementing mathematical and numerical techniques in computer calculations leading to solutions of physical problems. Topics include algorithms, models, and their applications. Quantum computing.

Course Code: PHYCS 531 **Course Title: APPLIED OPTICS** **(3-0-3)**
Nature and properties of light, lasers and their applications, non linear optics, Kerr's and Pockel's effects, magneto and accousto optic effects, display devices, photodetectors, fiber optical waveguides, optical communication systems.

Course Code: PHYCS 532 **Course Title: QUANTUM OPTICS** **(3-0-3)**
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 533 **Course Title: NONLINEAR OPTICS** **(3-0-3)**
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 534 **Course Title: OPTOELECTRONICS** **(3-0-3)**
Propagation of rays and beams in lens like media and fibers; optical resonators; interaction of radiation with atomic systems; electro-optic modulation of laser beams; interaction of light and sound; optical communication; holography
.

Course Code: PHYCS 535 **Course Title: ATOMIC AND MOLECULAR SPECTRA** **(3-0-3)**
Fourier transform spectroscopy; microwave spectroscopy; infrared and Raman spectroscopies; electronic spectroscopy of atoms and molecules; spin resonance spectroscopy; Mossbauer spectroscopy, laser spectroscopy.

Course Code: PHYCS 536 **Course Title: LASER PHYSICS** **(3-0-3)**
Introduction to laser 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 537 **Course Title: PHOTOPHYSICS** **(3-0-3)**
Light emission resulting from electronic transitions between excited states of atoms; molecules; semiconductors; insulators and biological systems

Course Code: PHYCS 538 Course Title: SELECTED TOPICS IN APPLIED PHOTONICS (3-0-3)
The study of a particular topic of current interest in applied photonics. Topics are to be selected with the consent of the Departmental's Postgraduate Committee.

Course Code: PHYCS 541 Course Title: CLASSICAL ELECTRODYNAMICS (3-0-3)
Electrostatics and boundary value problems; Maxwell's equations and conservation laws; time varying fields; gauge transformations; Lorentz and Coulomb gauges; Green's function of electromagnetic waves; Poynting theorem and conservation laws of a system of charged particles; plane electromagnetic waves and wave propagation; linear and circular polarization; simple radiating systems; cavities and wave guides.

Course Code: PHYCS 551 Course Title: SOLID STATE PHYSICS (3-0-3)
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 552 Course Title: SOLID STATE DEVICES (3-0-3)
Basic equations for semiconductor devices; carrier transport phenomena; carrier concentration at thermal equilibrium; heterojunctions; metal-semiconductor contacts; tunnel devices; transfer-electron devices; LEDs and semiconductor lasers; photodetectors; photovoltaic phenomena, microwave devices and solar cells.

Course Code: PHYCS 553 Course Title: SEMICONDUCTORS (3-0-3)
Carrier concentrations in thermal equilibrium; defects and impurity states; excess carriers in semiconductors; radiative and non-radiative recombinations; electron transport phenomena; thermal effects in semiconductors; optical and high frequency effects in semiconductors; diffusion of electrons and holes; methods characterizing semiconductors; element and compound semiconductors; theory of p-n junction.

Course Code: PHYCS 554 Course Title: MATERIALS SCIENCE (3-0-3)
Introduction to materials; synthesis of materials; material's characterizations; phase diagram and crystallization; structure and microstructure; heat and mass transfer; mechanical properties; metals and alloys; amorphous and glasses; polymers; magnetic materials; semiconductors; thin films; biomaterials

Course Code: PHYCS 555 Course Title: PHYSICS OF NON-CRYSTALLINE SOLIDS (3-0-3)
The nature of the glassy states; structure of glasses; oxide glasses, halide glasses; elemental glasses; hydrogen bonded glasses; chalcogenide glasses; theoretical ideas of amorphous semiconductors; Anderson's localization; band structure; Mott-CFO model; Davis and Mott model; optical properties and spectroscopic properties; electronic states and transport properties in non-crystalline solids; applications of amorphous semiconductors.

Course Code: PHYCS 556 Course Title: NANOSCIENCE AND NANOMATERIALS (3-0-3)
Introduction to the nanoworld; 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 557 Course Title: NANOTECHNOLOGY (3-0-3)
Introduction to nanotechnology; nanostructured films; nanoelectronics & information technology; nanophotonics; nanomaterials for medical diagnosis and therapy; nanobiosensors; nano/bio-MEMS; nanobiotechnology; recent advances in nanotechnology.

Course Code: PHYCS 558 Course Title: SELECTED TOPICS IN CONDENSED MATTER PHYSICS (3-0-3)
The study of a particular topic of current interest in condensed matter physics. Topics are to be selected with the consent of the Departmental' s Postgraduate Committee.

Course Code: PHYCS 560 Course Title: THERMAL AND STATISTICAL PHYSICS (3-0-3)
Introduction to statistical physics; entropy and temperature; microcanonical, canonical and grand canonical ensembles; Liouville theorem; translational, vibrational and rotational partition functions; Boltzmann, Fermi-Dirac, and Bose-Einstein statistics; Bose-Einstein condensation; density matrix; principle of detailed balance; quantum statistics applications.

Course Code: PHYCS 561 Course Title: ENVIRONMENTAL PHYSICS (3-0-3)
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 562 Course Title: PHYSICS OF ARID AREAS (3-0-3)
Sand movements; confirmatory measurements in the desert; potential of hybrid solar irrigation systems; desalination as a strategy in arid-zone salinity management; modeling the dry climates; remote sensing for land system surveys; soil physics.

Course Code: PHYCS 563 Course Title: GLOBAL WARMING AND CLIMATE CHANGE (3-0-3)
Introduction to global warming and climate change; 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 564 Course Title: ADVANCED EARTH SCIENCE (3-0-3)
Natural resources; risks, hazards and resources associated with solid Earth systems; surface Earth systems; the ocean-atmosphere system; environmental impact of natural resources exploitation; natural hazards and their mitigation; seismic hazards; volcanic hazards; flooding; coastal erosion; ocean-atmosphere interaction; climatic change and global warming; human response to climate change and disasters.

Course Code: PHYSICS 565 Course Title: PHYSICS OF BUILDING ENVIRONMENT (3-0-3)
The environment; thermal insulation in buildings; energy use in buildings; air control in buildings; artificial and natural lights in buildings; noise and sound insulation; room acoustics; efficient electricity use in buildings; water supply and waste water in buildings; green buildings; Photovoltaic integrated building wind turbine integrated building; case studies.

Course Code: PHYCS 566 Course Title: ATMOSPHERIC PHYSICS (3-0-3)
Thermodynamic effect of water vapor parcel buoyancy; atmospheric stability; mixing and convection; observed properties of clouds; formation of cloud droplets; rain and snow; precipitation process; server storm and hail; weather radar; numerical cloud models.

Course Code: PHYSICS 567 Course Title: RENEWABLE ENERGY RESOURCES AND TECHNOLGY (3-0-3)
Principles of renewable energy; essentials of fluid mechanics; heat transfer; solar radiation; solar water heating; other uses for solar heat; photovoltaic generation; nano-technology in PV technology; hydro-power; wind power; the photosynthetic process; biofuels; wave energy; tidal energy; ocean thermal energy conversation (OTEC); geothermal energy; energy storage and distribution; economy of renewable energy; investment in renewable energy.

Course Code: PHYCS 568 Course Title: SELECTED TOPICS IN ENVIRONMENTAL PHYSICS (3-0-3)
The study of a particular topic of current interest in environmental physics. Topics are to be selected with the consent of the Departmental's Postgraduate Committee.

Course Code: PHYCS 591 Course Title: EXPERIMENTAL TECHNIQUES IN APPLIED PHYSICS (2-3-3)
Advanced experiments in applied physics such as: 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 599 **Course Title: THESIS** **(0-18-6)**

The student must conduct a research project in a specified and approved topic in one of the offered streams in applied physics. The research project will be supervised by a specialized academic member(s) and it will be submitted as a thesis which will be examined by a selected panel of external and internal examiners.