

Post –graduate Studies in Physics

1-Introduction:

The department of physics- college of science at King Saud University admits students (males and females) for master degree in physics. At present the department also offers a Ph.D. in theoretical physics. Acceptance is in accordance with the general rules and regulations of the college of Higher studies. Students should consult these for more information.

Students not graduated from the physics department at KSU are requested, if necessary, to take complementary courses to the courses completed somewhere else.

The M.Sc. and Ph.D. programs consist of a number of courses and a thesis. Number of hours required to complete M.Sc. programs are 24 hours and they are 18 hours for Ph.D. on theoretical physics

A. M.Sc. programs

The department of physics at KSU offers the following fields for the M.Sc.

1-Experimental nuclear physics 2-expermental laser physics 3- experimental material science 4- experimental solar energy 5- theoretical physics

The department of physics has approved plans for the M.Sc. and the Ph.D. programs courses, time plan, and thesis plan.

All students should study two courses in quantum physics and two courses in mathematical physics. The remaining courses are chosen according to the particular specialization to fulfill the requirements of the plan and to enable the student to gain the necessary skill and background in physics. It is expected that the student will finish 15 hrs in the first and second semester and 9 hrs in the third semester. During this period the student should submit a plan of his thesis to the department to be approved by the department board, college board and by the college of higher studies board.

B- ThePh.D program

The department offers a Ph.D in theoretical physics. Five courses are compulsory and one course is optional (see below) . Ph.D. thesis writing follows the general instructions issued by the college of higher studies .

M.Sc. courses in Physics

Study plan

College of Science

Physics Department

M.Sc. Programme

Level (first Semester)

Nuclear Physics

S.NO	Course Number	Course title	Number of Credit Hours
1	501 Phys.	Mathematical Physics (1)	2
2	551Phys.	Quantum Mechanics (1)	2
3	503 Phys.	Experimental Data Analysis	2
4	540Phys.	Statistical Mechanics	2

Second

semester

S.NO	Course Number	Course title	Number of Credit Hours
1	502 Phys.	Mathematical Physics (2)	2
2	552 Phys.	Quantum Mechanics (2)	2
3	580 Phys.	Nuclear Structure	3

Third semester

S.NO	Course Number	Course title	Number of Credit Hours
1	582 Phys.	Techniques in Nuclear Physics	3
2	584 Phys.	Reactor Physics	3
3	586 Phys.	Techniques in Health Physics	3

Fourth semester

S.NO	Course Number	Course title	Number of Credit Hours
1	600 Phys.	Thesis	

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Study plan

College of Science

Physics Department

M.Sc. Programme

Level (first Semester)

Laser Physics

S.NO	Course Number	Course title	Number of Credit Hours
1	501 Phys.	Mathematical Physics (1)	2
2	551Phys.	Quantum Mechanics (1)	2
3	503 Phys.	Experimental Data Analysis	2
4	530Phys.	Electromagnetic Theory	2

Second semester

S.NO	Course Number	Course title	Number of Credit Hours
1	502 Phys.	Mathematical Physics (2)	2
2	552 Phys.	Quantum Mechanics (2)	2
3	531 Phys.	Laser Physics	3

Third semester

S.NO	Course Number	Course title	Number of Credit Hours
1	532 Phys.	Quantum Optics Laboratory	3
2	534 Phys.	Laser Spectroscopy of Diatomic Molecules	3
3	535 Phys.	Atomic Spectroscopy	3

Fourth semester

S.NO	Course Number	Course title	Number of Credit Hours
1	600 Phys.	Thesis	

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Study plan

College of Science
Physics Department
Level (first Semester)

M.Sc. Programme

Solar Energy

S.NO	Course Number	Course title	Number of Credit Hours
1	501 Phys.	Mathematical Physics (1)	2
2	551Phys.	Quantum Mechanics (1)	2
3	503 Phys.	Experimental Data Analysis	2
4	530Phys.	Electromagnetic Theory	2

Second semester

S.NO	Course Number	Course title	Number of Credit Hours
1	502 Phys.	Mathematical Physics (2)	2
2	552 Phys.	Quantum Mechanics (2)	2
3	574 Phys.	Material Science	3

Third semester

S.NO	Course Number	Course title	Number of Credit Hours
1	572 Phys.	Semiconductors	3
2	573 Phys	Physical Applications Of X- Rays	3
3	575 Phys.	Solar Energy Conversion	3

Fourth semester

S.NO	Course Number	Course title	Number of Credit Hours
1	600 Phys.	Thesis	

Study plan

College of Science
Physics Department

M.Sc. Programme

Level (first Semester)

Material Science

Level (first Semester)

S.NO	Course Number	Course title	Number of Credit Hours
1	501 Phys.	Mathematical Physics (1)	2
2	551Phys.	Quantum Mechanics (1)	2
3	503 Phys.	Experimental Data Analysis	2
4	540Phys.	Statistical Mechanics	2

Second semester

S.NO		Course title	Number of Credit Hours
1	502 Phys.	Mathematical Physics (2)	2
2	552 Phys.	Quantum Mechanics (2)	2
3	570 Phys.	Theory of Solids	3

Third semester

S.N O	Course Number	Course title	Number of Credit Hours
1		Optional Course (Table 1)	3
2		Optional Course (Table 1)	3
3		Optional Course (Table 1)	3

Fourth semester

S.NO	Course Number	Course title	Number of Credit Hours
1	600 Phys.	Thesis	

Study plan

College of Science

Physics Department

M.Sc. Programme

Level (first Semester)

Theoretical Physics

S.NO	Course Number	Course title	Number of Credit Hours
1	501 Phys.	Mathematical Physics (1)	2
2	551Phys.	Quantum Mechanics (1)	2
3	530Phys.	Electromagnetic Theory	2
4	540Phys.	Statistical Mechanics	2

Second semester

S.NO	Course Number	Course title	Number of Credit Hours
1	502 Phys.	Mathematical Physics (2)	2
2	552 Phys.	Quantum Mechanics (2)	2
3	561 phys.	Elementary Particle Physics. (1)	3

Third semester

S.NO	Course Number	Course title	Number of Credit Hours
1		Optional Course (Table 2)	3
2		Optional Course (Table 2)	3
3		Optional Course (Table 2)	3

Fourth semester

S.NO	Course Number	Course title	Number of Credit Hours
1	600 Phys.	Thesis	

M.Sc. Programme

PHYS 501 Mathematical Physics I (2+0) credit hours.

Review of ordinary differential equations. Bowed Stretched String. Expansion of Green's function. Electrostatics, Forced drum. Helmholtz equation, radiation. Point source. Diffusion Neumann series. Froholm formulae. Hilbert theory.

PHYS 502 Mathematical Physics II (2+0) credit hours.

The discontinuity problem. Dispersion relations. Spectral representations. Green's functions and Fourier transforms. Laplace and Mellin transforms. Partial differential equations. Potential on semi-infinite plate. Diffraction by a knife edge.

PHYS 503 Experimental Data Analysis (1+1) credit hours.

Advanced Measuring instruments. Errors in physical measurements. Automatic a data acquisition and data organization. Distribution functions and their relations to physical measurements and characteristics. Curve analysis and its numerical techniques. Interpolation and extrapolation. Fourier analysis. Approximation methods in physics. Perturbative calculations of energy levels and spectra. Computer programming with relevant examples from physics.

PHYS 512 General Relativity I (3+0) credit hours.

Review of Tensor Calculus, field equations and Schwartzchild solution. Integral conservation laws. Electromagnetism in general relativity. Linearized theory of gravitation. Far fields. Gravitational Waves. The Cauchy problem in general relativity.

PHYS 513 General Relativity II (3+0) credit hours.

Invariant characterization of exact solution. Killing vectors. Solutions with special symmetry properties. Gravitational collapse and black holes. Global techniques. Singularity Theorems.

PHYS 530 Electromagnetic Theory

Review of Maxwell's Equations. Propagation of electromagnetic waves. Reflection and refraction. Wave guides of resonant cavities. Radiating systems. Special relativity and electromagnetic fields.

PHYS 531 Laser Physics (3+0) credit hours.

Basic Laser Theory. Threshold condition and rate equations. Theory of oscillation and radiation modes for resonators. Q-switching and mode locking. Types of Lasers; Conventional Lasers; X-ray and x-ray lasers. Non-linear phenomena; Frequency conversion. Raman Effect, Multiphoton absorption. Laser applications in engineering, Communications, Radar, Holography and Optical data processing and Laser Isotope separation.

PHYS 532 Quantum Optics Laboratory (0+3) credit hours.

Optical Pumping Experiments. Fiber Optics Characteristics measurements. Holography. Spatial Filtering. Raman Scattering. Study of Characteristics of Nitrogen Laser Pumped Dye Laser System.

PHYS 534 Laser Spectroscopy of Diatomic Molecules (3+0) credit hours.

Types of bonding in molecules. Rotational, Vibrational and Electronic spectra of diatomic molecules. Separated and United atom approximations. Classification of electronic terms. Method of Molecular orbital. Configuration Interaction. French- Condon Principles. Hund's coupling cases. Selection Rules. Vander Waals Binding. Dissociation and Predissociation. Determination of repulsive potential curves by Laser Photodissociation studies.

PHYS 535 Atomic Spectroscopy (3+0) credit hours.

Hydrogen atom. Electronic configurations of atoms. Penetrating orbits in alkali metals. Lande's theory for fine structure splitting. Coupling Scheme's for two-valence electrons. Term designation of atoms with equivalent electrons. Configuration interactions. Life-time transition probability, Oscillator strengths. Zeeman & Stark effects. Natural and collisional broadening and shift of spectral line. Hyperfine structure. Very high resolution spectroscopy by RF Optical summing, Level crossing and double resonance techniques.

PHYS 540 Statistical Mechanics (2+0) credit hours.

Postulates of quantum statistical mechanics. Micro canonical ensemble. Grand canonical ensemble. Ideal Bose gas, Photon gas. Ideal Fermi gas. Degeneracy pressure; equilibrium in stellar structure. Interacting systems. Mayer cluster expansion.

PHYS 551 Quantum Mechanics I (2+0) credit hours.

Applications of quantum theory in atomic, molecular and nuclear physics. Rotation group. Representations. Clebsch – Gordan Coefficients. Spin-orbit interaction. Hyperfine Structure. Scattering theory. Phase shifts. Resonances. Analytic S-matrix.

PHYS 552 Quantum Mechanics II (2+0) credit hours.

Relativistic wave equation, Dirac equation. Electron in interaction. Quantum theory of radiation. Second quantization. Many-body theory.

PHYS 555 Quantum Field Theory I (3+0) credit-hours

Photons and the Electromagnetic field. Lagrangian Field Theory. Klein Gordon Field. Dirac Field. Covariant theory of Photons. S-Matrix Expansion. Feynman Diagrams in QED. Lowest order QED processes.

PHYS 556 Quantum Field Theory II (3+0) credit-hours.

One-Loop Renormalization. Radiative Corrections to the Interaction with an external Field. Photon-Photon Effects. Lamb Shift. Regularization and Power Counting. Renormalization. Zero Mass Limit. Asymptotic Behavior Weinberg's Theorem. Renormalization in QED.

PHYS 557 Quantum Field Theory III (3+0) credit hours.

The Action Functional. Functional Methods in Quantum Mechanics. Feynman Path Integral in Field Theory. Perturbative Evaluation. Path Integrals in Gauge Theories. Perturbative evaluation of gauge Theories.

PHYS 561 Elementary Particle Physics I (3+0) credit hours.

Brief review of Particle Detectors and Accelerators. Invariance Principles and Conservation Laws. Hadron – Hadron interaction. Isospin. Strangeness. G-parity. Static Quark Model of Hadrons. Quark model for Baryons. Baryon Magnetic moments. Heavy-meson spectroscopy. Search for free Quarks.

PHYS 562 Elementary Particle Physics II (3+0).

Introduction to Weak Interactions. Muon Decay. Transition Probability. Neutron – Electron Scattering. Intermediate vector Boson W. General properties of Hadronic Weak Currents. Nuclear beta Decay. Muon Capture. Unitary Symmetry; SU₂, SU.

PHYS 563 Elementary Particle Physics III (3+0).

Brief review of Symmetries in Field Theory. The standard SU(3) x SU(2) x U(1) gauge theory. SU(2) x U(1), spontaneous symmetry breaking, Goldstone Theorem. Higgs mechanism. The Parton model. Deep inelastic lepton – nucleon scattering. Radiative SU(2) x U(1) correction to the standard model. Application to Non-leptonic weak decays.

PHYS 570 Theory of Solids (3+0) credit hours.

Crystal Structure and Symmetry in Crystals; Electron State in Solids; Energy Band Calculations; Impurity States; Electronic Properties; Thermodynamic Properties and Transport Properties, Optical properties, Lattice Vibrations and Phonons; Magnetism in Solids, Dielectric properties.

PHYS 571 Electron Paramagnetic Resonance (3+0) credit hours.

Magnetic dipoles in a magnetic field. Magnetic moments and angular momenta... . The resonance condition. EPR instrumentation. Frequency and temperature variation. Time dependent phenomena. Relaxation times. Line shapes. Hyperfine interactions. Isotopic systems, Anisotropic systems. Transition elements. The spin Hamiltonian. Free radicals. Point defects.

PHYS 572 Semiconductors (3+0) credit hours.

Band structure of Semiconductors. Imperfections in semiconductors. Carrier concentration at thermal equilibrium. Thermal conductivity and thermoelectric power. Optical absorption in semiconductors. Non-Equilibrium carrier phenomena. The p-n junction. Fermi level, internal electric field, diffusion potential. Experimental techniques. Conductivity, mobility, thermo-power life time.

PHYS 573 Physical Application of X-Rays (2+1) credit hours.

Properties of X-rays, Diffraction of X-rays, Intensities of Diffracted beams, Experimental methods. Interpretation of powder patterns. Orientation of single crystals. Parameter measurements, Chemical analysis by X-Ray diffraction, Structure of poly – crystalline aggregates, Correction of diffraction data.

PHYS 574 Materials Science (3+0) credit hours.

Crystalline Solids & Glasses. Metallic elements. Types of defects. Diffusion in solids. Concept of activation energy. Nucleation and growth. Crystal faces and grain boundaries. Recrystallization. Phase changes and phase diagrams. Determination of Phase diagrams by: thermal analysis, X-ray diffraction and Metallography. Preparation techniques for ceramics, sintered materials and alloys. Temperature control. Electric and magnetic alloys. Memory shape alloys.

PHYS 575 Solar Energy Conversion (3+0) credit hours.

Solar radiations. Current transport mechanism in p-n junctions. The photovoltaic effect. Current voltage characteristics under illumination. Conversion efficiency. Factors influencing the conversion efficiency. Spectral response. Technology of silicon cells. Polycrystalline and amorphous silicon cells. Heterojunction solar cells. Schottky barrier and MIS cells.

PHYS 576 Theory of Magnetism (3+0) credit hours.

Atomic theory of Magnetism. Kinds of Magnetisms; Diamagnetism, Paramagnetism, Ferromagnetism and Anti ferromagnetism, Heisenberg the Ising Models; Localized Magnetic Impurities, S-d Hamiltonien and Kondo Effect. Effective Field Theories. Spin Glasses and Amorphous Magnetism.

PHYS 580 Nuclear Structure (3+0) credit hours.

Nucleon – Nucleon Forces. Nuclear Shapes and Nuclear Moments. Nuclear Shell Model. Collective and Unified Models. Microscopic Theory of Nuclear Structure.

PHYS 582 Techniques in Nuclear Physics (2+1) credit hours.

Measurement of X and Gamma Ray energies and intensities, measurement of charged particles spectra, magnetic spectrometers and measurement of momentum for charged particles, neutron detection, particle beam detection, scattering chambers, pulse processing electronics, particle identification techniques, coincidence measurements, angular correlation and lifetime measurements.

PHYS 584 Reactor Physics (3+0) credit hours.

Decay of fission fragments, prompt and delayed neutrons, slowing down of neutrons; Fermi age theory, Diffusion of neutrons; multi group diffusion theory, Fuel depletion Fission product poisoning, Reactor Kinetics, Concept of reactivity, Classical aspects of reactor control, Control aspects of delayed neutrons and reflectors; Integral transport theory, Solution of transport

equation, Fast breeder reactor, possible breeding cycles, doubling time, breeding ratio, Cell parameters, physics of PWR and Fast Breeder Reactor.

PHYS 586 Techniques in Health Physics (2+1) credit hours.

Measurement of ionization as applied to dosimetry, ionization methods of mixed radiation dosimetry, measurement absorbed dose, cavity-chamber theory, special methods in radiation dosimetry, Physics of diagnostic radiology, X-ray generating apparatus, the radiological image, the image receptor, X-ray flouroscopy, subtraction technique, topography radionuclide imaging, the Gamma-Camera, Scanning Cameras, ECAT, Computed tomography, principles of diagnostic ultrasound, basic principles of NMR and their application to imaging. Radiation protection guides.

PHYS 599 Special Topics (3+0) credit hours.

Discussion of topics relevant to the graduate students based on the specific interest of the students and the requirements of their programs.

Study plan

College of Science
Physics Department

Ph.D Programme
Theoretical Physics

Level (first Semester)

S.NO	Course Number	Course title	Number of Credit Hours
1	557 Phys.	Quantum Field Theory -3	3
2	563 Phys.	Elementary Particle Physics -3	3

Second semester

S.NO	Course Number	Course title	Number of Credit Hours
1	653 Phys.	Quantum Electrodynamics	3
2	657 Phys.	Advanced Quantum Field Theory	3

Third semester

S.NO	Course Number	Course title	Number of Credit Hours
1	658 Phys.	The Electroweak Model	3
2		Optional Course Table (3)	3

Fourth semester

S.NO	Course Number	Course title	Number of Credit Hours
1	700 Phys.	Thesis	

