جامعة الملك خالد
KING KHALID UNIVERSITY

College of science
Physics Department

MSc HANDBOOK

Content

1 Overview

Overview

The aim of this Handbook of Master's Program is to provide sufficient information about the Master of Science (Physics) program at King Khalid University.

The Master's program in the Department of Physics was established in 1425 AH and the first graduates of the program were in 1428AH.

During the period from 1428 to 1445, 91 distinguished graduates graduated from the program in various specializations. Many of the department's graduates have held many important positions after obtaining doctoral degrees from prestigious international universities.

The Master's program at the Department of Physics at King Khalid University has contributed and continues to enrich Saudi universities with many distinguished faculty members.

2 Mission and Objectives

Mission and Objectives

Mission

Excellence in higher education and scientific research related to fields of physics, with the focus on graduation of highly qualified students in physics and related applications, who contribute to community service and sustainable development.

Objectives

1.Contributing to the achievement of the Kingdom's Vision 2030 and its national development plans.
2. Providing a motivating academic environment that supports students in acquiring advanced skills and knowledge in recent developments in physics.
3.Developing students' leadership abilities in scientific research in physics, independence, and teamwork and preparing them for the job market to achieve sustainable development.
4.Competence in conducting and presenting research projects to the academic community, with the aim of contributing to community development.
5.Diversify and develop funding sources and their sustainability.

3 Admission and Graduation requirements

Admission and Graduation requirements

Admission and requirements

1- The applicant’s bachelor’s average should not be less than 3.5 out of 5, or its equivalent.
2- Passing the supplementary courses specified by the scientific department for non-graduates of the Faculty of Science at the university.
3- Passing one of the English language tests specified below with a score of no less than: TOEFL-IBT: 45 points - STEP: 67 - IELTS: 4.

Graduation requirements

1- The student should complete twenty-six study units with very good grade.
2- The student submits a thesis project and is equivalent to six study units.
3- The master's thesis should be written in English, provided that it contains an adequate abstract in Arabic.

4 Acceleration Plan and Tracks (Specialization)

Acceleration Plan and Tracks (Specialization)

Acceleration Plan

- An outstanding graduate student can complete his/her academic requirements for a master's degree in just four semesters. This can be achieved by registering four courses during the first and second levels instead of the previous three courses in the traditional plan.
- The student also has the freedom to choose between the traditional plan and the acceleration plan according to his/her abilities and excellence, after receiving feedback from the academic advisor.
- Based on the updated graduate regulations, a student can submit a thesis research plan proposal after completing 50% of the program courses.

Tracks (Specialization)

- Solid state physics
- Nuclear physics
- Quantum optics
- Optics and lasers

5 Program Learning Outcomes

Program Learning Outcomes

College of science
Physics Department

KNOWLEDGE

1- Define basic and advanced scientific knowledge, facts, and concepts in Physics and related fields.
2- Outline an advanced level of knowledge and familiarity with recent concepts and theories in his/her field of specialization in Physics.
3- Describe recent practical applications of physics and their contributions to innovative developments.
4- State recent theories and scientific techniques in physics and methods of verification.

SKILLS

1- Using various principles and theories to address and resolve related problems.
2- Use diverse physical concepts and advanced theories to solve problems and make predictions within his/her field of specialization in physics.
3- Apply advanced mathematical and practical skills in physics to analyze, evaluate, and interpret scientific data.
4- Employ digital technologies with optimal efficiency.
5- Show both independent and teamwork capabilities and demonstrate leadership skills.
6- Acquire proficiency in e-learning and self-study skills along with excellent communication skills.

VALUES

1- Behave professionally and adhere to ethical scientific values.
2- Practice volunteering work and participate in national strategies to address community issues.
3- Perform assigned tasks, take initiative, and assume full responsibility.
4- Be able to constructive criticism, and self-evaluation, and exhibit personal qualities and abilities.

6 Study plan

Study Plan

King Khalid University
Science College
Physics Department

جامعة الملك خالد
كلية العلوم
قسم الفيزياء

Study plan of the Master of Science in Physics program

(Number of program hours = 32)

First year

Level 1			
Code	Course Name	Hr	Requisite
6001 Phys 3	Advanced classical mechanics	3	-
6002 Phys 3	Electromagnetic theory	3	-
6004 Phys 3	Advanced mathematical physics	3	-
Total		9	

Level 2			
Code	Course Name	Hr	Requisite
6003 Phys 3	Quantum mechanics I	3	-
6005 Phys 3	Statistical mechanics	3	-
****	Elective course (1)	3	-
Total		9	

Second year

Level 3			
Code	Course Name	Hr	Requisite
6006 Phys 3	Advanced physics lab	3	-
6007 Phys 2	Seminar	2	-
****	Elective course (2)	3	Elective course (1)
Total		8	

Level 4			
Code	Course Name	Hr	Requisite
6009 Phys 6	Thesis	6	-
Total		6	

Elective course			
Code	Hr	Course Name	Requisite
6101 Phys	3	Solid state physics	6003 Phys
6201 Phys	3	Nuclear physics	6003 Phys
6301 Phys	3	Atomic structure and spectroscopy	6003 Phys
6401 Phys	3	Quantum optics	6002 Phys
6008 Phys	3	Quantum mechanics II	6003 Phys
6102 Phys	3	Special topics in solid state physics	6003 Phys
6202 Phys	3	Special topics in nuclear physics	6201 Phys
6302 Phys	3	Special topics in atomic physics	6301 Phys
6402 Phys	3	Special topics in quantum optics	6401 Phys

Study Plan

Program specification

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Course Syllabus

Advanced Classical Mechanics

6001 PHYS-3

1. COURSE DESCRIPTION

This course includes mainly about Calculus of variations, Lagrange and Hamilton equations, Motion in central fields, Classical scattering problems and cross section

2. COURSE MAIN OBJECTIVE

The main purpose of this course is to teach the students the following topics:
Calculus of variations, Lagrange and Hamilton equations, Motion in central fields, Classical scattering problems and cross section.

Required Textbooks	*Classical Mechanics, Herbert Goldstein, Charles Poole Jr., John Safko (Pearson) 3rd edition (2001).*
Essential References Materials	*Classical Mechanics, John R. Taylor (University Science Books) (2005).*

Electromagnetic theory

6002 PHYS-3

1. COURSE DESCRIPTION

The course covers some advanced mathematical skills required to deal with Boundary value problems in Electrostatics Magnetostatics, Faraday's law, quasi static fields, Maxwell's equations and macroscopic electromagnetism, conservation laws, Plane electromagnetic waves and waves propagation, waveguides, resonant cavities, and optical fibers

2. COURSE MAIN OBJECTIVE

The objectives of this course are to teach the students the advanced Electromagnetic theory in physical sciences. After completion of this course, students will have to deal with the following.

- *Maxwell's equations and macroscopic electromagnetism, conservation laws,*
- *Plane electromagnetic waves and wave propagation, waveguides, resonant cavities, and optical fibers.*

Required Textbooks	*- John David Jackson- Classical Electrodynamics, Wiley 1999.* *- D. J. Griffiths, Introduction to electrodynamics, Pearson International edition. 1999.*
Essential References Materials	*Electronic lectures in Blackboard.* *https://lms.kku.edu.sa/webapps/portal/frameset.jsp*

Quantum Mechanics I

6003 PHYS-3

1. COURSE DESCRIPTION

This quantum mechanics course introduces the historical background and postulates of wave mechanics. It covers mathematical tools such as the Hilbert space, wave functions, and Dirac notation. Topics include observables, measurement processes, uncertainty relations, and the time evolution of quantum systems. The course explores properties of one-dimensional motion, potential barriers, and the harmonic oscillator. Additionally, it covers the theory of angular momentum, permutation symmetry, and approximation methods for stationary states.

2. COURSE MAIN OBJECTIVE

The basic ideas and concepts of quantum mechanics: Hilbert spaces, bra-ket formalism, operators, matrix representation, observables, the measurement process, uncertainty relations, the position and momentum representation, density matrices, Bell's inequalities.
Quantum dynamics: temporal evolution, Schrödinger and Heisenberg picture, the propagator, path integrals.
Harmonic oscillator, creation, and annihilation operators.
Symmetries in quantum mechanics: translation, rotation, parity, spatial and temporal inversion.
The theory of angular momentum: ladder operators, spin, addition of angular momentum.
Permutation symmetry, identical particles.
Many particle systems formalisms with the goal of its further application in the quantum mechanics.
Approximation methods for time-independent and time-dependent problems, the interaction picture.

Required Textbooks	*Quantum Mechanics: concepts and applications by NouredineZettili. – 2nd ed*
Essential References Materials	*Electronic Journal websites.* *Quantum Physics News :* *https://phys.org/physics-news/* *https://phys.org/physics-news/*

Advanced Mathematical Physics

6004 PHYS-3

1. COURSE DESCRIPTION

Analytical functions- residue calculus- contour integration's-conformal mapping-linear operators-integral transformations-generalized and Dirac functions-differential equations of mathematical physics and boundary value problems: wave equation-Laplace equation-Schrodinger equation- quantum mechanical applications.

2. COURSE MAIN OBJECTIVE

The main purpose of this course is to teach the students the following topics:

Analytical functions - residue calculus - contour integration – conformal mapping - linear operators - integral transformations - generalized and Dirac functions -differential equations of mathematical physics and boundary value problems – wave equation - Laplace equation - Schrodinger equation – quantum mechanical applications.

REQUIRED TEXTBOOKS	*Mathematical methods for physical sciences, 3th edition Boas (Wiley) (2005).*
ESSENTIAL REFERENCES MATERIALS	*Mathematical Methods for Physicists, G. B. Arfken and H. J. Weber (Elsevier) 7th edition (2013).*

Statistical Mechanics

6005 PHYS-3

1. COURSE DESCRIPTION

The present course contains the main scope to strengthen the understanding of non-interacting particle statistical physics (classic or quantum) and develop the case of classic or quantum interacting particles. Then open the door for more advanced topics in statistical physics such as field's statistical physics (critical phenomena).
Each course chapter is followed by many completely solved problems which are a valuable learning tool and naturally develop the subject and illustrate different applications.

2. COURSE MAIN OBJECTIVE

The main objectives of this course are:
1-To review and reinforce the understanding of the kinetic theory of gas as well as classic or quantum description of microstates.
2- To review and reinforce the understanding of non-interacting particles (classic and quantum) statistical physics with the focus on applications in different domains.
3- To focus on Interacting particles statistical physics (classic and quantum) with the focus on applications (non-ideal gas, liquid and solutions, slightly interacting fermions or bosons)
4-Tp introduce fields statistical physics: with as main focus critical phenomena and many bodies problems

Required Textbooks	- *Introduction to statistical physics, Kerson Huang* - *Fundamentals of statistical and thermal physics." Reif, Frederick. (1998)*
Essential References Materials	*Statistical Mechanics Pathria, R. K., and Paul D. Beale. (2011)*

Advanced Physics Laboratory

6006 PHYS-3

1. COURSE DESCRIPTION

Renewing the references available on the network or via information technology.
Studying new valuable experiments.
Using different learning sources such as English scientific literature.
Applying various learning tools such as data show, whiteboard, and many computer programs (Word, Excel, Origin, and PowerPoint).

2. COURSE MAIN OBJECTIVES

Applying the advanced characterization methods for solid-state, and nuclear physics and surface science by carrying out some experiments.
Perform and analyze the data of these experiments by using advanced laboratory equipment.
Using many computer programs such as (Origin Lab, ICCD database, Raman database, and Smile View in calculating and analyzing the results.
Writing the lab report for each experiment by using the results and the appropriate references

Required Textbooks	*1- Euth Ortiz Ortega, et al, Material Characterization Techniques and Applications, Springer Nature Singapore Pte Ltd. 2022* *2- Dalip Singh Verma, et al., Handbook of Materials Characterization, Springer International Publishing AG, part of Springer Nature 2018*
Essential References Materials	*1- Nikolai V. Tkachenko , Optical Spectroscopy: Methods and Instrumentations 1st Edition, Nikolai Tkachenko, Elsevier Science 2006.* *2- Nicholas Tsoulfanidis, Sheldon Landsberger , Measurement and detection of radiation, Taylor & Francis Group, LLC 2021.*

Seminar

6007 PHYS-2

1. COURSE DESCRIPTION

The nature of this course is lab training to provide students with specific knowledge and skills in their area of research. This includes preparation of literature review, writing scientific reports, and delivering oral presentations

2. COURSE MAIN OBJECTIVE

The purpose of this course is to provide students with specific training in their area of research

Required Textbooks	*Lab manuals, research articles*
Essential References Materials	*Data show projector, Mat Lab, Mathematica*

Quantum Mechanics II

6008 PHYS-3

1. COURSE DESCRIPTION

This course aims to acquire students more advanced skills in quantum mechanics required to deal with atomic and optics problems in physics. This course treats non-relativistic and relativistic quantum mechanics in more details. It covers some advanced topics including quantum dynamics, symmetry and conservation laws, scattering theory and identical particles.

2. COURSE MAIN OBJECTIVE

To develop advanced concept in quantum mechanics that are required to understand the realistic atomic and subatomic systems.

To acquire students the skills of applying some mathematical tools in quantum mechanics to study advanced non-relativistic atomic and subatomic problems.

To give the skills of relativistic quantum mechanics required to treat quantum systems of high energies.

Required Textbooks	*Sakurai, Napolitano,Modern Quantum Mechanics, 2ed, Addison-Wesley, 2011* *Quantum Mechanics, Eugen Merzbacher, Wiley 1997*
Essential References Materials	*Electronic Journal websites.* *Quantum Physics News :* *https://phys.org/physics-news/* *https://phys.org/physics-news/*

Thesis

6009 PHYS-3

1. COURSE DESCRIPTION

A thesis is considered a partial fulfillment of the requirements of master degree in science – physics. After completion of his/her thesis, the students should be able to:
State related basic scientific facts, concepts, principles and advanced techniques related to his/her thesis proposed of his/her field.
Think independently, set tasks and solve problems on scientific bases.
Analyze, assess and interpret qualitatively and quantitatively science relevant data of his/her thesis proposed.
Perform a research study and/or write a systematic scientific study on a physical research problem related to his/her thesis proposed.
Write professional and research reports.
Communicate effectively both orally and in writing, selecting and using forms of presentation appropriate for differing issues and audiences.
Respect the rules, public ethics and the scientific traditions.

2. COURSE MAIN OBJECTIVE

Postgraduate committee consists of qualified scientific staff; they are responsible for monitoring MSc program quality.
Activating the recommendations of these committees through periodical meeting.
The curriculum includes dissertation project with 6 credit hours

Required Textbooks	*Published research articles in refereed journals.* *Research articles of the faculty members.*
Essential References Materials	*Wolfram (website for mathematica software).*

Solid State Physics

6101 PHYS-3

1. COURSE DESCRIPTION

This course is designed to introduce students to the structure, electronic properties, and other basic properties of solids. The course is supposed to cover in detail the representation of crystal structure, symmetries in solids, X-ray diffraction, transport properties, electronic structure, lattice vibration, optical properties and outlines of magnetism, and superconductivity. Concepts are carefully developed in logical, problem-solving steps, leading to a concrete understanding of the topics.

2. COURSE MAIN OBJECTIVE

The aim of this course is to study in detail the following topics:
1- Structural properties and symmetry of solids
Visual materials
2- Electronic and electrical properties
3- Thermal properties
4-Optical properties
5- Magnetic materials and superconductivity

Required Textbooks	*Kittel, Charles - Introduction To Solid State Physics 8Th Edition*
Essential References Materials	*Elementary Solid State Physics Principles and Applications, M. A. Omar., 1993*

Special topics in solid state physics

6102 PHYS-3

1. COURSE DESCRIPTION

The course is to teach the students:
1. Optical properties of materials
2. photoconductivity and photovoltaic of material
3. Experimental Technique
4.Magnetic and superconductivity materials

2. COURSE MAIN OBJECTIVE

The purpose of this course is to find the relationship between the optical properties of materials and the photoconductivity and photovoltaic of materials. Secondly studies the magnetic and superconductivity processing of the materials

Required Textbooks	*Charles Kittel, Introduction to Solid State Physics (Wiley: New York, 2004).* *Solid State Physics By A J Dekker.*
Essential References Materials	*Solid state physics (structure and properties of materials), M A Wahab, Narosa Publisher*

Nuclear physics

6201 PHYS-3

1. COURSE DESCRIPTION

The course covers the following subjects:
Hadrons, Nucleons, and Pions - Nuclear force and other fundamental forces - Anti-particles, inversion, and parity - Isospin and strangeness. Mesons and baryons - Fundamental forces and exchanged bosons - The two nucleon system, electric and magnetic multi-poles - The deuteron wave function - Nucleon-Nucleon potential and phenomenological potentials - Nuclear radii and binding energy - Electric and magnetic multi-poles of nuclei - Excited states of nuclei and nuclear stability - Liquid drop model - Fermi gas model – Shell model.
Plan for developing and improving the course :
The course website (on Blackboard) includes video lectures, pdf files of lectures, many others books, and notes. It also includes a discussion forum to discuss questions, answers, and current scientific issues

2. COURSE MAIN OBJECTIVE

The main purposes of this course are :
The students learn about the main concepts and methods of nuclear physics.
The student learn about new discoveries in the field of nuclear physics.
The students are prepared to start their own research in nuclear

Required Textbooks	*Introductory Nuclear Physics by K. Krane (John Wiely) 3rdedition 1987* *Nuclear Physics in a Nutshell by C. A. Bertulani (Princeton University Press) 1st edition 2007*
Essential References Materials	*The Berkeley Laboratory Isotopes Project's (Exploring the Table of Isotopes).* *http://pdg.lbl.gov/2014/AtomicNuclearProperties/outsidelinks.html*

Special Topics in Nuclear physics

6202 PHYS-3

1. COURSE DESCRIPTION

Studying of Secondary Beams of Rare Isotopes.
Nucleus-Nucleus Scattering at High Energies.
Sizes and Energies of Exotic Nuclei.
Break-Up Reactions and Momentum Distributions
Fusion Reactions

2. COURSE MAIN OBJECTIVE

The main objective of this course is to provide a comprehensive understanding of various aspects of nuclear physics, focusing on the following key topics:
Nuclear static properties: This involves learning about the measurement techniques used to determine the size of atomic nuclei.
Physics of Radioactive Beams and Borromean Nuclei: Students will explore the unique properties and behavior of radioactive beams, including the study of Borromean nuclei.
Studying secondary beams of rare isotopes: This topic delves into the analysis and examination of secondary beams composed of rare isotopes.
Scattering theory: Students will learn about scattering phenomena in nuclear physics, including the Born approximation and time-independent perturbation theory.
Sizes and energies of exotic nuclei: This component focuses on understanding the sizes and energies associated with nuclei that exhibit unusual or rare characteristics.
Nucleus-nucleus scattering at high energies: Students will explore the interactions and collisions between atomic nuclei under high-energy conditions.

Required Textbooks	*Physics of Radioactive Beams; Authors: Bertulani, C.A, Hussein, M.S, Münzenberg, G. Nova Science Publishers, 2001 - Nuclear structure*
Essential References Materials	*Introductory Nuclear Physics, Kenneth S. Krane, John Wiley & Sons; 3rd edition (1987)*

Atomic Structure and Spectroscopy

6301 PHYS-3

1. COURSE DESCRIPTION

CHAPTER (1) Bohr Model & Hydrogen Spectrum
CHAPTER (2) One electron atoms - Hydrogen-like ions
CHAPTER (3):Electric and Magnetic Field Effects:
CHAPTER (4) Atom with many electrons atoms – n- electrons atoms
CHAPTER (5) Theory and approximations
CHAPTER (6) Cross Sections & Scattering
CHAPTER (7) Atom/electron and Atom/atom collisions

2. COURSE MAIN OBJECTIVE

The objectives of this course are to teach the postgraduate students atomic structure and electronic configuration of n-electron atoms, starting from the subsequent Bohr and Schrödinger Models and ending with applications to atomic collisions. After completion of this course, students will know the following:
Scattering, Cross Sections, the semi-classical Bohr Model, Schrödinger Model, Electronic structures of n-electron atoms, Fine and Hyperfine.
Theory and approximations: Central field Approximation, Hartree - Fock method

Required Textbooks	*The Theory of Atomic Structure and Spectra / Robert D. Cowan.*
Essential References Materials	*https://lms.kku.edu.sa/webapps/portal/frameset.jsp* *-Physics of Atoms and Molecules/Bransden and Joachain. Electronic lectures in Blackboard.*

Special Topics in Atomic Physics

6302 PHYS-3

1. COURSE DESCRIPTION

This course covers various topics in the field of atomic physics related to the faculty's expertise and the student's needs. Topics selected will extend knowledge of special topics covered by the earlier course of Physics 6301 at the master level. Topics will be chosen based on the instructor and the student's research direction.

2. COURSE MAIN OBJECTIVE

To enable students to study particular topics in atomic physics and the new problems in the field.

Required Textbooks	*Physics of Atoms and Molecules; by B. H. Bransden , Charles J. Joachain ; Second Edition; Publisher: Prentice Hall (Pearson Prentice Hall (Pearson Education Ltd) 2014.*
Essential References Materials	*Saudi digital library and other electronic resourcesSaudi digital library and other electronic resources*

Quantum optics

6401 PHYS-3

1. COURSE DESCRIPTION

This course aims to give main details in the general subject: Quantum dynamics of two-level atoms and light. To this end, students need to study the classical, semiclassical, and fully quantized theory for the atom-light interaction. As applications, this course will concentrate on the determination of A&B Einstein Coefficients, the solutions for the optical Bloch equations, and dealing with Jaynes-Cummings model.

2. COURSE MAIN OBJECTIVE

The students deal with Quantum dynamics of two-level atoms:
- A and B Einestein coeffients
- Bloch equations-pulse propagation-quantization of electromagnetic field-states of EM field-coherence theory
- Atom field interactions:Jaynes Cummings interaction and dressed states
-Theory of spontaneous emission

Required Textbooks	*1-R. Loudon, The quantum theory of light (2000,Oxford)* *2- M. Scully and S. Zubairy Quantum optics,(1997,Cambridge)*
Essential References Materials	*M. Sergant III and P. Meystre , Elemets of quantum optics (1999,Oxford)*

Special Topics in Quantum Optics

6402 PHYS-3

1. COURSE DESCRIPTION

This course aims to cover the remaining subjects not given in the Quantum Optics course. Then, it uses general methods for studying atom-light interaction, namely the master equation. Damped Jaynes-Cummings model will be covered and application of this model in quantum information processing.

2. COURSE MAIN OBJECTIVE

The course will cover:
subjects that are not given in the previous course, Quantum Optics course.
Master equations for two-level atom and light interaction
Damped Jaynes-Cummings model
Applications in Quantum information processing.

Required Textbooks	*Methods in theoretical quantum optics, Stephen Barnett and Paul Radmore, Oxford, 1997* *Fundamentals of Quantum Optics and Quantum Information, Peter Lambropoulos, Springer, 2007*
Essential References Materials	*Introductory Quantum Optics, Christopher Gerry and Peter Knight, Cambridge, 2004*

8 Research Groups

Research Groups

College of science
Physics Department

Master’s thesis in the Department of Physics, King Khalid University, are distinguished by the great diversity of research topics given that the department has many research groups and many research capabilities in specialized laboratories.

1. Condensed Matter Theory
2. Nuclear energy science
3. Optics and laser technology
4. Thin Film Science and Technology
5. Plasma and fusion research
6. Photoelectric properties and applications
7. Advanced materials and nanotechnology
8. Alloys and compounds

9 Graduate attributes

Graduate attributes

1. Commitment to Islamic values and national identity.
2. Acquiring advanced skills and knowledge in recent developments in his/her field of specialization in physics.
3. Competence in using information technology.
4. Having the ability to demonstrate a professional ethic and commitment to continuous learning, independence, responsibility, and teamwork.
5. Demonstrating competence in conducting and presenting research projects to the academic community with a focus on making contributions to community development.

10 Contact

Contact with the department

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