## Master's degree curriculum
## First semester

| Symbol | Number of units | Number of weekly hours | | Subject |
|---|---|---|---|---|
| | | Lap. | Theo. | |
| 501 | 3 | - | 3 | Advanced Solid State |
| 502 | 3 | - | 3 | Nuclear Advanced |
| 503 | 3 | - | 3 | Mathematical Physics |
| 504 | 3 | - | 3 | Quantum Mechanics |
| 505 | 2 | - | 2 | Nano- Physics |
| 506 | 1 | - | 1 | English Language |
| | 15 | - | 15 | Total hours/units |

| | |
|---|---|
| Lecturer Name | Ass.Prof.Alaa abdul hakeim hamed |
| Subject Name | Advance Quantum Mechanics I / |
| Academic Year | 2023- 2024 |
| Credit Hours | 3 hours in week |

Students do study the following fields:

1. Tools and postulates of Q.M.
2. Angular momentum
3. Rotation and addition of angular momentum.
4. Equation of motion.
5. Dirac notation.

Course Outcomes:

1. The cours begins with the experimental basis of quantum mechanics, where we look at those atomic and subatomic phenomena which confirm the failure of classical physics at the microscopic scale and establish the need for a new

approach. Then come the mathematical tools of quantum mechanics such as linear spaces, operator algebra, matrix mechanics, and eigenvalue problems; all these are treated by means of Dirac's bra-ket notation. After that we discuss the formal foundations of quantum mechanics and then deal with the exact solutions of the Schrödinger equation when applied to one-dimensional and three-dimensional problems. We then look at the stationary and the time-dependent approximation methods.

2. to give a self-contained, yet concise, presenta tion of most issues of nonrelativistic quantum mechanics, and to offer a rich collection of fully solved examples and problems. This unified format is not without cost. Size! Judicious care has been exercised to achieve conciseness without compromising coherence and completeness.

Weekly Teaching Plan

| | |
|---|---|
| Week 1, 2 | The Schrödinger equation |
| Week 3,4 | Momentum and the uncertainty principle |
| First Quiz | |
| Week 5,6 | Mathematical tools of quantum mechanics |
| Week 7,8 | The Hilbert space and wave functions |
| Second Quiz | |
| Week 9,10 | Representation in Discrete bases |
| Week 11,12 | Representation in continuous bases |
| Third Quiz | |
| Week 12, 13 | The harmonic oscillator |
| Week 14,15 | Angular momentum |
| Course Final Term Exam | |

Computer Usage: Good
Teaching Techniques: theoretic
Assessment methods: E-Learning

References (text book) :
1-Quantum mechanics. by Powell & Crascman
2-Q.M. concepts & applications. by Zettili
3- Introduction to Quantum mechanics by J.Griffths

| | |
|---|---|
| Lecturer Name | Mohammed Khayri Zeki Abed |
| Subject Name | Mathematical Physics |
| Academic Year | 2023- 2024 |
| Credit Hours | 3 |

**Students do study the following fields:**

6. Vector Analysis, Coordinate Systems.
7. Tensor Analysis.
8. Group Theory, Gamma and Beta Functions.
9. Matrices.
10. Gamma and Beta Functions
11. Function of complex variable – Calculus and Residues.
12. Laplace Transformation, Fourier Series, Fourier Transform , Integral Transform.

**Course Outcomes:**

3. Learn mathematics and how to use in physics.

**First Semester**

**Weekly Teaching Plan**

| | |
|---|---|
| Week 1, 2 **(3-9-2023)** | **Topics Covered**: **Vectors**: (addition, multiplication, associatation, etc.), Scalar, Vector Dot Product, Vector Cross Products, Triple Scalar and Triple Vector Product, (examples), Differentiation of Vectors, Directional Derivative, Gradient, Divergence, Curl, Successive applications of ∇ . (Questions for Practices) |
| Week 3,4 | **Topics Covered** :Vector Integration(line, surface & volume integrals), Stock's Theorem, Gauss's Theorem, Potential Theory , Curvilinear Coordinates , Differential Operator, cylindrical, Spherical coordinates and their Transformations, ( Examples and Solved Problems) |
| **First Quiz** | |
| Week 5,6 | **Topics Covered** : **Tensor Analysis:** Covariant & Contravariant Tensors, Coordinates Transformations, Algebra Operations, Quotient Law, Fundamental Properties of Tensors, Symmetric and Anti-symmetric Tensors, Kronecker Tensor, pseudo Scalar and Tensors, Eigen values and Eigen vectors of second ordered Tensor, Dirac Delta Function. |
| Week 7,8 | **Topics Covered**: **Group Theory** : Group Axioms(definition), Subgroups, classes, Symmetry Operations, Matrix Representation of Group, Examples of Groups, types of Groups, Irreducible Representations of groups (examples) |
| **Second Quiz** | |
| Week 9,10 | **Topics Covered**: **Matrices**: Matrix Algebra, Type of matrices, Determinants, Inverse and Related Matrices, Elementary Transformations, Eigen values and Eigen vectors , Diagonalization of matrices, Functions of Matrices (examples ) |
| Week 11,12 | **Topics Covered**: **Gamma and Beta Functions**, Relation Between Beta and Gamma Functions (examples and Solved Problems) |
| **Third Quiz** | |
| Week 12, 13 | **Topics Covered**: **Functions of complex Variables**: Complex numbers(review), limits, continuity and derivatives, Demoivers Theorem, Powes, Roots, Analytic Function , Cauchy Integral, Taylor's and Laurent's Theorems, Singularities, Calculus of Residues and Applications, Evaluation of real definite integral by contour, Integration Round unit circle. |
| Week 14,15 **(15-1-2024)** | **Topics Covered**: **Laplace Transformation, Fourier Series, Fourier Transform , Integral Transform.** |
| **Course Final Term Exam** | |
| **Second Quiz** | |

**Computer Usage:**
**Teaching Techniques:**
**Assessment methods:**
**References (text book) :**

**1- Peter O'Neil, 2003, Advanced Engineering Mathematics, 5th Edition.**
**2- Arfken, G. 1973, Mathematical Methods for Physicist (2nd ed.; Cambridge, MA: Academic Press).**
**3- Dass, H., K., 2009, Mathematical Physics , S. Chand ,India.**

| |
|---|
| 1. Course Name: |
| Advanced Solid State Physics |
| 2. Course Code: |
| |
| 3. Semester / Year: |
| /2024 – 2025 |
| 4. Description Preparation Date: |
| 18-2-2024 |
| 5. Available Attendance Forms: |
| Presence |
| 6. Number of Credit Hours (Total) / Number of Units (Total) |
| 45 / 3 Units |
| 7. Course administrator's name (mention all, if more than one name) |
| Name: Asset Prof. dr. Mahmood Ahmad Hamood<br>Email: dr.mahmood@uomosul.edu.iq<br>Name : Prof. dr. Mazin Ahmed Abed<br>Mazin: mazinahmedabed@uomosul.edu.iq |
| 8. Course Objectives |

| | |
|---|---|
| **Course Objectives** | 1. The learn more advance things in solid state physics<br>2. Enabling the student to study some advanced specialization in solid state physics.<br>3. Developing the mental ability of the doctoral student by assigning him to solve a large number of questions and to be able to reach correct answers to specific questions that include the application of physical principles.<br>4. Developing the ability to formulate analytical questions<br>5. Preparing the student for the future in postgraduate studies.<br>6. Through the narration in each chapter , the student remains exposed to the question: Why? Or can you explain that?<br>7. Each chapter concludes with a set of cognitive questions to develop the student's ability to apply the principles of solid state physics in a |

| | |
|---|---|
| | qualitative manner |

## 9. Teaching and Learning Strategies

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|---|---|
| **Strategy** | Method and procedure, which includes:<br>1- Presentation and detailed explanation<br>2- Problem posing and discussion And ask perceptive questions.<br>3- Teaching the student how to formulate and ask questions through the teacher's words.<br>4- Understanding current applications of solid state physics and exposure to new horizons of applications |

## 10. Course Structure

| Week | Hours | Required Learning Outcomes | Unit or subject name | Learning method | Evaluation method |
|---|---|---|---|---|---|
| 1,2 | 6 | 1.1.Introduction<br>2.1.Superconductivity<br>3.1. General properties superconductor<br>4.1.Missiner Effect<br>5.1. Critical Tempera -ture , Field, Current<br>6.1. Type I and type II superconductors | Super conductor | The main teaching method combination lecture-based methodsWhich elocution detailed explana And method Interactive Discussion Between the teacher And students Involving students in educational process | Discussion Individuality And collectivism Duties Exams, The quick Exams Editorial search Assigning the student to give the lecture in place of the professor |
| 3,4 | 6 | 7.1. Differences between type I and Type II superconductor<br>8.1. Penetration depth<br>Summary<br>Glossary of Important Terms<br>Review Question<br>Problems<br>Quiz | | | |
| 5,6 | 6 | 9.1. BCS Theory<br>10.1. Brothers London's Equation<br>11.1.Cooper Paries<br>12.1.Fiux quantization<br>13.1.Critical parame -ter of super | | | |

| | | | | | |
|---|---|---|---|---|---|
| 7,8 | 6 | conductor<br>14.1.Effect of Magnetic Field<br>15.1 Effect of Current<br>16.1.Isotopic Effect<br>17.1.Josephson Effect<br>Summary<br>Review Question<br>Solve Problems | | | |
| 9,10 | 6 | Quiz<br>2.1. Introduction<br>2.2.Original Phenome -non of Magnetism<br>2.3. Classification Magnetic Material<br>2.4. Hound Rule<br>2.5. Langvan's Theory for Diamagnetic<br>2.6. Quantum Theory for Paramagnetic<br>2.7.Paramagnetic Susceptibility of conduction electrons<br>2.8.Propertiesof Ferromagnetic material<br>2.9.Properties-of Antiferromagnetic Material<br>Summary<br>Review Question<br>Solve Problems | Magnetic Properties of Material | | |
| 11,12 | 6 | | | | |
| 13,14 | 6 | Quiz<br>3.1.Introduction<br>3.2.Different between Dielectric and conductor<br>3.3.Behaviour-of dielectrics in electric field | | | |

| | | | | | |
|---|---|---|---|---|---|
| 13,14<br><br>15 | 6<br><br>3 | 3.4. Non- polar dielectrics<br>3.5.Polar electrics<br>3.6.Dielectric polarization<br>3.7.Dielectric constant<br>3.8. Three electric vector and their relation<br>3.9. Boundary condition at the dielectric surface<br>Summary<br>Review question<br>Solve Problems | Semiconducto Device | | |

## 11. Course Evaluation

Distributing the score out of 100 according to the tasks assigned to the student such as daily preparation, daily oral, monthly, or written exams, reports .... etc

## 12. Learning and Teaching Resources

| | |
|---|---|
| Required textbooks (curricular books, if any) | |
| Main references (sources) | |
| Recommended books and references (scientific journals, reports…) | 1. Introduction to Superconductivity , Second Edition by Michale Tankham, 2004.<br>2. Superconductivity An Introduction By , Roland Combescot 2022 |
| Electronic References, Websites | |

## Master's degree curriculum
## Second semester

| Symbol | Number of units | Number of weekly hours | | Subject |
|---|---|---|---|---|
| | | Lap. | Theo. | |
| 511 | 3 | - | 3 | Statistical Mechanics |
| 512 | 3 | - | 3 | Advanced Electromagnetic |
| 513 | 2 | 2 | 1 | Analysis Technique |
| 514 | 2 | - | 2 | Selective Subject |
| 515 | 1 | - | 1 | English Language II |
| 516 | 1 | 2 | - | Advance Programming and Internet |
| | 12 | 4 | 10 | Total hours/units |

| | |
|---|---|
| Lecturer Name | Advanced Electromagnetics Theory (MSc Students) |
| Subject Name | Maxwell's Equations and its Solutions |
| Academic Year | 2023- 2024, 2nd Semester |
| Credit Hours | 3 |

Students do study the following fields:

1- Electromagnetics
2- Maxwell's Equations and its Applications.
3- Relativistic Electrodynamics

Course Outcomes:

1- Study of Advance Electrodynamics theory Physics and Applications
2- Electromagnetics waves physics and properties
3- Relativistic Electrodynamics

Weekly Teaching Plan

| | |
|---|---|
| Week 1 | Maxwell's Equation |
| Week 2 | Application on Maxwell's Equation |

| | |
|---|---|
| Discussions | |
| Week 3 | Gauge Transformation |
| Week 4 | Application |
| Second Quiz | |
| Course Final Term Exam | |

Computer Usage: Good
Teaching Techniques: Explanation
Assessment methods: Presentations
References (text book):

1- Introduction to Electrodynamics, David 1. Griffiths and Reed College. y Prentice-Hall, Inc., 1999.
2- Classical Relativistic Electrodynamics, Toshiyuki Shiozawa, Springer, 2004
3- Introduction To Quantum Field Theory, P.J. Mulders, 2003

| | |
|---|---|
| Lecturer Name | Cold Plasma Physics(Msc.) |
| Subject Name | Elective Subject |
| Academic Year | 2023- 2024, 2nd Semester |
| Credit Hours | 3 hours |

Students do study the following fields:
1. Plasma Physics.
2. Charged Optics Physics.

Course Outcomes:
Mastering Cold Plasma Physics and Applications
Weekly Teaching Plan

| | |
|---|---|
| Weeks 1, 2 | Literature review introduction |
| Weeks 3, 4 | Plasma Applications. |
| First Quiz | |
| Weeks 5, 6 | Cold Plasma Generations |
| Weeks 7, 8 | Cold Plasma interaction with the matter |
| Second Quiz | |
| Weeks 9, 10 | Cold Plasma sanitizations |
| Weeks 11, 12 | Project Discussion |
| Third Quiz | |
| Weeks 13, 14 | Project Discussion |
| Course Final Term Exam | |

Computer Usage: Good
Teaching Techniques: Explanation
Assessment methods: Presentations

References (text book) :


- Kushner, Mark J. "Plasma physics and engineering." Cambridge University Press, 2005.
- Fridman, Alexander, et al. "Plasma medicine." John Wiley & Sons, 2013.
- Graves, David B., et al. "Plasma Medicine: Applications of Low-Temperature Gas Plasmas in Medicine and Biology." Cambridge University Press, 2018.


## وصف المقرر الدراسي

| | |
|---|---|
| Lecturer Name | Haitham Abdelhameed Ahmad Al-Rawachy |
| Subject Name | Statistical mechanics /Msc. |
| Academic Year | 2023 – 2024 |
| Credit Hours | 3 |

**Students do study the following fields:**

1. Maxwell-Boltzmann Statistics
2. Applications of Maxwell-Boltzmann Statistics
3. Bose-Einstein Statistics
4. Fermi-Dirac Statistics
5. Temperature and Entropy
6. The Thermodynamics of Gases

**Course Outcomes:**

1. This subject represents an attempt to give an introduction to statistical physics in a form which is suitable for postgraduate students.

2.The material has been chosen in order to emphasize the basic methods of statistical physics and those results which are of particular importance for physicists.

3. The applications of statistical physics which have been given, both in the text and as problems, have been chosen to illustrate the methods of statistical mechanics and statistical thermodynamics rather than to provide a comprehensive survey of these applications.

**Weekly Teaching Plan**

| | |
|---|---|
| Week 1, 2 | Maxwell-Boltzmann Statistics |
| Week 3,4 | Applications of Maxwell-Boltzmann Statistics |
| **First Quiz** | |
| Week 5,6 | Bose-Einstein Statistics |
| Week 7,8 | Fermi-Dirac Statistics |
| **Second Quiz** | |
| Week 9,10 | Fermi-Dirac Statistics |
| Week 11,12 | Temperature and Entropy |
| **Third Quiz** | |

| | |
|---|---|
| Week 12, 13 | The Thermodynamics of Gases |
| Week 14,15 | The Thermodynamics of Gases |
| **Course Final Term Exam** | |

**Computer Usage: Good**
**Teaching Techniques: Explanation**
**Assessment methods: review papers in statistical physics**

**References (text book) :**

1- An Introduction to Statistical Physics for Students. A. J. Pointon 1967

## Doctoral Degree curriculum
## First semester

| Symbol | Number of units | Number of weekly hours | Subject |
|---|---|---|---|
| 501 | 3 | 3 | Solid state (I) |
| 502 | 3 | 3 | Material science (I) |
| 503 | 3 | 3 | Spectroscopy Analysis |
| 504 | 3 | 3 | Advanced Quantum Mechanics |
| 505 | 2 | 2 | Solid State Electronics |
| 506 | 1 | 1 | English language |
| | 15 | 15 | Total hours/units |

| | |
|---|---|
| Lecturer Name | Relativistic Quantum Mechanics (PhD Students) |
| Subject Name | Advanced Quantum Mechanics |
| Academic Year | 2023- 2024, 1nd Semester |
| Credit Hours | 2 |

Students do study the following fields:

1- Fundamental Quantum Mechanics

Course Outcomes:

Relativistic Quantum Mechanics formulations and Applications

Weekly Teaching Plan

| | |
|---|---|
| Week 1 | Klein Gordan Equation |
| Week 2 | Klein Gordan Equation Solution and Applications |
| Quiz | |

| | |
|---|---|
| Week 3 | Dirac Equation |
| Week 4 | Applications of Dirac Equation |
| Quiz | |
| Course Final Term Exam | |

Computer Usage: Good
Teaching Techniques: Explanation
Assessment methods: Presentations
References (text book) :

a. Griffiths - Introduction to quantum mechanics
b. Anthony G. Williams - Introduction to Quantum Field Theory - Classical Mechanics to Gauge Field Theories-Cambridge University Press (2022)
c. Griffiths_D_J_Introduction_to_quantum_mechanics_2nd_ed_Solutions. "Introduction to Surface Engineering and Functionally Engineered Materials" by Peter J. Martin
e. Wolfgang Hollik - Introduction To Quantum Field Theory And The Standard Model (2022).

**2023-2024**

| | |
|---|---|
| Lecturer Name | Mohammed Khayri Zeki Abed |
| Subject Name | Quantum Mechanics |
| Academic Year | 2023- 2024 |
| Credit Hours | 3 |

**Students do study the following fields:**

1. Historical Notes.
2. Mathematical Tools of Quantum Mechanics
3. Representation in Discrete Bases., Solved problems and Exercises.
4. Schrodinger Equation .
5. Quantum Tunneling .
6. Perturbation Theory .
7. Scattering Theory .
8. The Harmonic Oscillator .
9. Wentzel – Kramers – Brillouin (WKB) Approximation .

**Course Outcomes:**

1. Learn mathematics and how to use in physics.

# First Semester

**Weekly Teaching Plan**

| | |
|---|---|
| Week 1, 2 **(3-9-2023)** | **Topics Covered**: **Historical Notes** : Founder of Quantum Mechanics , The old quantum theory , Quantum Theory Development , The main features of quantum mechanics , Significance of Quantum Mechanics . |
| Week 3,4 | **Topics Covered** : **Mathematical Tools of Quantum Mechanics**. The Hilbert space, Dirac notation and Wave function, Hermitian operators , Eigenvalue problem and Expectation , Commuting operators , Uncertainty principle… |
| | |
| Week 5,6 | **Topics Covered** : **Representation** : Position and Momentum Representations |
| Week 7,8 | **Topics Covered: Schrodinger Equation :** Schrödinger picture, Heisenberg picture , Interaction picture. |
| | |
| Week 9,10 | **Topics Covered**: **Quantum Tunneling** : potential well wave functions for the bound state , |
| Week 11,12 | **Topics Covered**: **Perturbation Theory:** Time dependent and independent perturbation theory :Example : harmonic oscillator . |
| | |
| Week 12, 13 | **Topics Covered**: Scattering Theory : Differential cross section in classical and quantum mechanics |
| Week 14,15 **(15-1-2024)** | **Topics Covered**: **The Harmonic Oscillator**: classical and quantum theory, Wentzel – Kramers – Brillouin (WKB) Approximation, exercises and solved problems . |
| **Course Final Term Exam** | |
| | |

**Computer Usage:**
**Teaching Techniques:**
**Assessment methods:**
**References (text book) :**

**1- Quantum Mechanics : John L. Powell . Addion- Wesly publishing Company , INC.**
**2- Quantum Mechanics: Concepts and Applications, Nouredine Zettili.**
**3- - Introduction to Quantum Mechanics, D. J. Griffiths.**

## Doctoral Degree curriculum
## Second semester

| Symbol | Number of units | Number of weekly hours | Subject |
|---|---|---|---|
| 611 | 3 | 3 | Solid state (II) |
| 612 | 3 | 3 | Material science(II) |
| 613 | 3 | 3 | Selective subject |
| 614 | 2 | 2 | Measurement techniques |
| 615 | 1 | 1 | English language |
| 616 | – | 2 | Internet |
| | 12 | 14 | Total hours/units |