Course Information

COURSE INFORMATION

Course Title	Code	Semester	L+U Hour	Credits	ECTS
Advanced Quantum Mechanics II	FZ-6004		3 + 0	3.0	7.5

Prerequisites	None
Language of Instruction	Turkish
Course Level	Third Cycle
Course Type	Elective
Mode of delivery	Face to face
Course Coordinator	Prof. Dr. Serhat ÖZDER
Instructors	Assist. Prof. Dr. Ayşe KÜÇÜKARSLAN
Assistants	
Course Objectives	To gain basic knowledge about the theoretical foundation of quantum mechanics of many particles system
Course Content	The Wentzel – Kramers – Brillouin approximation method, One dimensional WKB solutions Bound States for Potential wells, Energy levels of a potential well, Tunneling through a Potential Barrier Spin Angular Momentum, The Spin Operator, Pauli Matrices, and Spin Angular Momentum Eigenvalues, Quantum Dynamics of a Spin System Spin and Rotations, Euler Rotations, Spinors The Addition of Angular Momenta, Calculation of the Clebsch – Gordan Coefficients, Coupling of Orbital and Spin Angular Momenta Addition of More than two Angular Momenta, Tensor operators and the Wigner – Eckart Theorem for Spherical Tensor Operators, Parity, and Time Reversal Identical Particles, Many Particle Systems, Symmetrization Postulates Systems of Identical Non-interacting Particles, Exclusion Principle and the Periodic Table Angular Momentum of System of Identical particles, Angular Momentum and Spin One Half Boson Operators, Helium Atom, First order perturbation theory in many Body Systems, The Hartree – Fock Method The calculus of Variations in Quantum Mechanics, The Rayleigh – Ritz Trial Function, Variation method for Bound States Spin – orbit forces, LS and jj coupling, The atom in LS coupling, The normal and anomalous Zeeman Effect. Field Quantization, Plane Waves, Photons, Polarization, Emission of a photon by an atom, Dipole emission The Cross Section, The Scattering of a Wave Packet, Green's Functions in Scattering Theory, The Born Approximation Elements of Relativistic Quantum mechanics, The Dirac and Klein – Gordon equations.
Course Learning Outcomes	1) understand general formalism of quantum mechanics 2) solve the three dimensional quantum systems 3) make calculation with approximation methods 4) understand angular momentum and spin concepts 5) solve symmetry and transformations in quantum mechanics

WEEKLY COURSE CONTENT

Week	Topics	Teaching and	Study Materials

Quick Access

Physics (PhD)
- Qualification Awarded
- Level of Qualification
- Qualification Requirements and Regulations
- Specific Admission Requirements
- Recognition of Prior Learning
- Profile of the Program
- Program Key Learning Outcomes
- Occupational Profile of Graduates
- Access to Further Studies
- Course Structure & Credits
- Exam Regulations & Assessment & Grading
- Graduation Requirements
- Mode of Study
- Programme Director(or Equivalent)
- Evaluation Questionnaire
- TYYÇ

Course Information
- Course Information
- Weekly Course Content
- Resources
- Course Category
- CONTRIBUTION OF COURSE LEARNING OUTCOMES TO PROGRAMME OUTCOMES
- ECTS credits and course workload

		Learning Methods and Techniques	
1. Week	The Wentzel – Kramers – Brillouin approximation method, One dimensional WKB solutions	Lecture, Homework, Practice	
2. Week	Bound States for Potential wells, Energy levels of a potential well, Tunneling through a Potential Barrier	Lecture, Homework, Practice	
3. Week	Spin Angular Momentum, The Spin Operator, Pauli Matrices, and Spin Angular Momentum Eigenvalues, Quantum Dynamics of a Spin System	Lecture, Homework, Practice	
4. Week	Spin and Rotations, Euler Rotations, Spinors	Lecture, Homework, Practice	
5. Week	The Addition of Angular Momenta, Calculation of the Clebsch – Gordan Coefficients, Coupling of Orbital and Spin Angular Momenta	Lecture, Homework, Practice	
6. Week	Addition of More than two Angular Momenta, Tensor operators and the Wigner – Eckart Theorem for Spherical Tensor Operators, Parity, and Time Reversal	Lecture, Homework, Practice	
7. Week	Identical Particles, Many Particle Systems, Symmetrization Postulates	Lecture, Homework, Practice	
8. Week	Midterm Exam	Written Exam	
9. Week	Systems of Identical Non-interacting Particles, Exclusion Principle and the Periodic Table	Lecture, Homework, Practice	
10. Week	Angular Momentum of System of Identical particles, Angular Momentum and Spin One Half Boson Operators, Helium Atom, First order perturbation theory in many Body Systems, The Hartree – Fock Method	Lecture, Homework, Practice	
11. Week	The calculus of Variations in Quantum Mechanics, The Rayleigh – Ritz Trial Function, Variation method for Bound States	Lecture, Homework, Practice	
12. Week	Spin – orbit forces, LS and jj coupling, The atom in LS coupling, The normal and anomalous Zeeman Effect	Lecture, Homework, Practice	
13. Week	Field Quantization, Plane Waves, Photons, Polarization, Emission of a photon by an atom, Dipole emission	Lecture, Homework, Practice	
14. Week	The Cross Section, The Scattering of a Wave Packet, Green's Functions in Scattering Theory, The Born Approximation	Lecture, Homework, Practice	
15. Week	Elements of Relativistic Quantum mechanics, The Dirac and Klein – Gordon equations.	Lecture, Homework, Practice	
16. Week	Final Exam	Written Exam	

RESOURCES

Recommended Sources
The Wentzel – Kramers – Brillouin approximation method, One dimensional WKB solutions
Stephen Gasiorowicz, "Quantum Physics"
R.L.Liboff, "Indroductory Quantum Mechanics

ASSESSMENT

Measurement and Evaluation Methods and Techniques

Midterm exam,Quiz,Final exam

COURSE CATEGORY

Course Category	Percentage
Core Courses	% 100

CONTRIBUTION OF COURSE LEARNING OUTCOMES TO PROGRAMME OUTCOMES

Programme Outcomes	Contribution Level	DK1	DK2	DK3	DK4	DK5
PY1	5	2	4	4	5	5
PY2	4	4	4	4	4	4
PY3	3	4	4	3	3	4
PY4	3	4	5	5	4	4
PY5	4	5	5	5	4	4
PY6	5	4	4	3	4	5
PY7	5	5	5	4	4	4
PY8	4	4	4	4	5	5
PY9	3	4	4	4	4	4
PY10	4	4	4	5	4	3
PY11	4	4	4	5	5	4
PY12	4	3	5	4	4	3
PY13	4	4	4	4	4	4
PY14	4	4	4	4	4	4
PY15	5	4	4	4	4	4

*DK = Course's Contrubution.

	0	1	2	3	4	5
Level of contribution	None	Very Low	Low	Fair	High	Very High

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ECTS CREDITS AND COURSE WORKLOAD

Event	Quantity	Duration (Hour)	Total Workload (Hour)
Class Hours (14 weeks)	14	3	42
Final Exam Preparation	1	15	15
Assignment 1	3	10	30
Final Exam	1	3	3
Presentation/Seminar	1	8	8
Mid Term Exam 1	1	3	3
Further Study	10	8	80
Mid Term Exam Preparation	1	10	10
		Total Workload	191
		Total Workload / 25.5 (s)	7.49
		ECTS Credit of the Course	7