هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	Classical Mechanics
Course Code:	PHY 6101
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**5(4 Lectures, 0 Lab, 2 Tutorial)**
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☑ Elective ☐	
3. Level/year at which this course is offered:	**Level 1/Year 1**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

This course is intended to develop and apply the Lagrangian and Hamiltonian mechanics to systems with constraints, rigid body dynamics, vibrations, central forces, and continuous systems. The emphasis is on the canonical structure of classical mechanics, in which the parallels to quantum mechanics are most transparent. The course starts with Hamilton's principle of least action to derive Lagrange's equations, and applies the formalism to dynamical systems with constraints. Conservation of energy, momentum, and angular momentum are linked to symmetry principles. Canonical transformation theory is also discussed with applications to rigid body motion, including the dynamics of tops.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate advanced knowledge and understanding of the following specific fundamental concepts in classical mechanics: Conservation laws and symmetries in physical systems, Motion of particle and systems of particles in three dimensions, Lagrangian formulation of mechanics, Dynamics of rigid bodies, Hamiltonian formulation of mechanics;
- Demonstrate an ability to effectively apply the abovementioned knowledge in solving problems involving motion in the following classic areas of mechanics: Motion of bodies with variable mass, 1D-oscillators and pendulums, Motion of 2D, 3D oscillators, central force problems, spherical pendulums, Numerical solution of non-linear problems leading to chaotic behavior, Use of Lagrangian method in systems with holonomic constraints, Motion of rigid bodies such as spinning tops, wheels, and low-symmetry objects, Use of Hamiltonian formulation in central force problems and rigid body motion;
- Demonstrate advanced quantitative reasoning and mathematical analysis skills;
- Demonstrate ability to use computational tools in the numerical solution of problems in classical mechanics.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Interpret the fundamental concepts of conservation laws and symmetries in classical mechanics.	K1
1.2	Discuss advanced knowledge of classical mechanics in solving problems involving motion in the following classic areas of mechanics.	K1
1.3	Demonstrate advanced quantitative reasoning and mathematical analysis skills.	K1
1.4	Explain the computational tools in the numerical solution of classical mechanics.	K2, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying Classical mechanics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	**Survey of the Elementary Principles:** Mechanics of a particle, Mechanics of a system of particles, Constraints, D'Alembert principle and Lagrange's equations, Velocity-dependent potentials and the dissipation function, Simple applications of the Lagrangian formulation.	**4**
2	**Variational Principles and Lagrange's Equations:** Hamilton's principle, Some techniques of the calculus of variations, Derivation of Lagrange's equations from Hamilton's principle, Extension of Hamilton's principle to nonholonomic systems, Advantages of a variational principle formulation, Conservation theorems and symmetry properties.	**12**
3	**The Central Force Problems:** Reduction to the equivalent one-body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classical orbits, The Virial theorem, The differential equation for the orbit.	**12**
4	**The Kinematics of Rigid Body Motion:** The independent coordinates of a rigid body, Orthogonal transformations, Formal properties of the transformation matrix, The Euler angles, The Cayley-Klein parameters and related quantities, Euler's theorem on the motion of a rigid body, Finite rotations, Infinitesimal rotations, Rate of change of a vector, The Coriolis effect.	**12**
5	**The Rigid Body Equations of Motion:** Angular momentum and kinetic energy of motion about a point, Tensors, The inertia tensor and the moment of inertia, The eigenvalues of the inertia tensor and the principal axis transformation, Solving rigid body problems and the Euler equations of motion, Torque-free motion of a rigid body, The heavy symmetrical top with one point fixed.	**8**
6	**Oscillations:** Formulation of the problem, The eigenvalue equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, Free vibrations of a linear triatomic molecule, Forced vibrations and the effect of dissipative forces.	**8**
7	**The Hamilton Equations of Motion:** Legendre transformations and the Hamiltonian equations of motion, Cyclic coordinates and conservation theorems, Derivation of Hamilton's equations from a Variational principle, The principle of least action.	**8**
8	**Canonical Transformations:** The equations of canonical transformation, Examples of canonical transformations, The harmonic oscillator, Poisson brackets and other canonical invariants, The angular momentum Poisson bracket relations.	**8**
Total		**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Outline the fundamental concepts of conservation laws and symmetries in classical mechanics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe and apply advanced knowledge of classical mechanics in solving problems involving motion in the following classic areas of mechanics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	State advanced quantitative reasoning and mathematical analysis skills.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Describe the computational tools in the numerical solution of classical mechanics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying Classical mechanics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	*H. Goldstein, C.P. Poole, J. Safko, Classical Mechanics, 3rd Edition, Addison-Wesley, 2001.*
Essential References Materials	*-L.D. Landau, E.M. Lifshitz, Mechanics, 3rd Edition, Butterworth–Heinemann, 1976.* *-S.T. Thornton, J.B. Marion, Classical Dynamics of particles and Systems, 5th Edition, Thomson Learning, 2004.*
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

T15

Course Specifications
(Postgraduate Degree)

Course Title:	Classical Electrodynamics
Course Code:	PHY 6121
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**5(4 Lectures, 0 Lab, 2 Tutorial)**						
2. Course type							
a.	University ☐	College ☐	Department ☑	Others ☐			
b.	Required ☑	Elective ☐					
3. Level/year at which this course is offered:	**Level 2/Year 1**						
4.Pre-requisites for this course (if any)**:**	**None**						
5. Co-requisites for this course (if any)**:**	**None**						

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	**72**	**100%**
2	**Blended**		
3	**E-learning**		
4	**Distance learning**		
5	**Other**		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	**48**
2	**Laboratory/Studio**	**0**
3	**Tutorial**	**24**
4	**Others** (specify)	**0**
	Total	**72**

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides a rigorous foundation for advanced classical electrodynamics and some of its applications. It covers the physics and classical mathematics necessary to understand electromagnetic fields in materials and at surfaces and interfaces. Particular focus is given to time-dependent phenomena in which the calculation of the time-dependent scalar and vector potentials, and electric and magnetic fields, can be traced to the Green function formalism. The course develops a good knowledge on the Boundary–Value Problems in Electrostatics, Multipoles, Electrostatics of Macroscopic Media, Dielectric, Magnetostatics, Time-Varying Fields, Maxwell's Equations, Conservations Laws.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate knowledge of fundamental concepts of classical electrodynamics;
- State the fundamental problems and theories of classical electrodynamics;
- Find in classical electrodynamics a wholly new and counterintuitive way of thinking about the world;
- Develop physical intuition, mathematical reasoning, and problem solving skills;
- Deal with conceptually rich and technically difficult theoretical problems;
- Know how to use the theory to discuss quantum phenomena quantitatively;
- Have learned the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;
- Have experienced the adept application of physics and mathematics to solve real life problems;
- Prepare for the necessarily rigorous sequence in physics.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Discuss the background and main features of the historical development of classical electrodynamics.	K1, K2
1.2	Interpret the physical phenomena of classical electrodynamics.	K1, K3
1.3	Define expressions for the energy both for the electrostatic and Magnetostatics fields, and derive Poyntings theorem from Maxwell's equations.	K1
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying classical electrodynamics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	**Introduction to Electrostatics:** Coulomb's law, Electric field, Gauss's law, Differential form of Gauss's law, Scalar potential, Surface distributions of charges and dipoles, Poisson's and Laplace's equations, Green's theorem, Uniqueness theorem, Formal solution of boundary-value problem, Green' functions, Electrostatic potential energy.	**12**
2	**Boundary–Value Problems in Electrostatics, I:** Method of images, Point charge and a grounded conducting sphere, Point charge and a charged, insulated, conducting sphere, Point charge and a conducting sphere at fixed potential, Conducting sphere in a uniform field, Method of inversion, Green's function for a sphere, Conducting sphere with hemispheres at different potentials, Orthogonal functions and expansions, Separation of variables in rectangular coordinates.	**12**
3	**Boundary-Value Problems in Electrostatics, II:** Laplace's equation in spherical coordinates, Legendre polynomials, Boundary-value problems with azimuthal symmetry, Spherical harmonics, Addition theorem for spherical harmoics, Cylindrical coordinates, Bessel functions, Boundary-value problems in cylindrical coordinates, Expansion of Green's functions in spherical coordinates, Use of spherical Grren's function expansion, Expansion of Green's functions in cylindrical coordinates.	**12**
4	**Multipoles, Electrostatics of Macroscopic Media, Dielectric:** Multipole expansion, Multipole expansion of the energy of a charge distribution in an external field, Macroscopic electrostatics, Simple dielectrics and boundary conditions, Boundary–value problems with dielectrics, Molecular polarizability and electric susceptibility, Models for molecular polarizabilty, Electrostatic energy in dielectric media.	**12**
5	**Magnetostatics:** Introduction and definitions, Biot and Savart law, Differential equations of Magnetostatics, Ampere's law, Vector potential, Magnetic induction of a circular loop of currents, Localized current distribution, magnetic moment, Force and torque on localized currents in an external field, Macroscopic equations, Boundary conditions, Uniformly magnetized sphere in an external field, Permanent magnets, Magnetic shielding.	**12**
6	**Time-Varying Fields, Maxwell's Equations, Conservations Laws:** Faraday's law of induction, Energy in the magnetic field, Maxwell's displacement current, Maxwell's equations, Vector and scalar potentials, wave equations, Gauge transformations, Green's function for the time-dependent wave equation, Initial-value problem, Kirchhoff's integral representation, Poynting's theorem, Conservation laws, Macroscopic equations.	**12**
Total		**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Outline the background and main features of the historical development of classical electrodynamics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	State the physical phenomena of classical electrodynamics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Define expressions for the energy both for the electrostatic and Magnetostatics fields, and derive Poyntings theorem from Maxwell's equations.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying classical electrodynamics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2	**Midterm Exam 1**	**5th week**	**20 %**
3	**Midterm Exam 2**	**9th week**	**20 %**
4	**Final Exam**	**13th week**	**40 %**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : • **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.** • **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.** • **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	*-J.D. Jackson, Classical electrodynamics, 3rd Edition, John Wiley and Sons, 1998.*
Essential References Materials	*-W. Greiner , Classical Electrodynamics, Springer-Verlag New York, Inc., 1998.* *-D. J. Griffith, Introduction to Electrodynamics, 4th Edition, Prentice Hall, 2013*
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester the course instructor should complete the course report, including a summary of student**

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

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Course Specifications (Postgraduate Degree)

Course Title:	**Mathematical Methods in Physics**
Course Code:	**PHY 6131**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours:	**5(4 Lectures, 0 Lab, 2 Tutorial)**		
2. Course type			
a. University ☐	College ☐	Department ☑	Others ☐
b. Required ☑	Elective ☐		
3. Level/year at which this course is offered:	**Level 1/Year 1**		
4.Pre-requisites for this course (if any)**:**	**None**		
5. Co-requisites for this course (if any)**:**	**None**		

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides an overview of the essential mathematical methods illustrated by applications to problems from various branches of physics. It is designed to provide first-year graduate students with the mathematical background for subsequent studies of advanced mechanics, classical electrodynamics, quantum theory, advanced statistical physics, and advanced solid-state physics.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate knowledge of fundamental concepts in mathematical methods in Physics and apply this knowledge to solve problems;
- Find in Mathematical Methods in Physics a wholly new and counterintuitive way of thinking about the world;
- Develop physical intuition, mathematical reasoning, and problem solving skills;
- Deal with conceptually rich and technically difficult theoretical problems;
- Know how to use the theory to discuss physics phenomena quantitatively;
- Have learned the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;
- Have experienced the adept application of physics and mathematics to solve real life problems;
- Prepare for the necessarily rigorous sequence in physics.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Interpret the mathematical methods and its governing laws.	K1, K3
1.2	Describe the techniques to solve problems in physics and state the importance of mathematical methods in physics.	K1, K3
1.3	Discuss the important of mathematical methods in the development of Physics.	K1, K2
2	**Skills:**	
2.1	Explain and summarize the basic knowledge gained from studying mathematical physics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S4
3	**Values:**	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	**Vector Analysis in Curved Coordinates and Tensors:** Orthogonal coordinates in R3, Differential vector operators, Special coordinate systems, Circular cylinder coordinates, Spherical polar coordinates, Tensor analysis, Contraction, Direct product, Quotient rule, Pseudotensors, Dual tensors, General tensors, Tensor derivative, Operators.	14
2	**Group Theory:** Introduction to group theory, Generators of continuous groups, Orbital angular momentum, Angular momentum coupling, Homogeneous Lorentz group, Lorentz covariance of Maxwell's equations, Discrete groups, Differential forms.	12

3	**Infinite Series:** Fundamental concepts, Convergence tests, Alternating Series, Algebra of Series, Series of functions, Taylor's expansion, Power series, Elliptic integrals, Bernoulli numbers, Euler–Maclaurin formula, Asymptotic series, Infinite products.	12
4	**Functions of a Complex Variable:** Complex algebra, Cauchy–Riemann conditions, Cauchy's integral theorem, Calculus of residues.	12
5	**The Gamma Function (Factorial Function):** Definitions, Simple properties, Digamma and polygamma functions, Stirling's series, The beta function.	10
6	**Differential Equations:** Partial differential equations, First-order differential equations, Separation of variables, Frobenius Method.	12
	Total	**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Outline the mathematical methods and its governing laws.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe the techniques to solve problems in physics and state the importance of mathematical methods in physics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Explain the important of mathematical methods in the development of Physics.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying mathematical physics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5thweek	20 %
3	Midterm Exam 2	9thweek	20 %
4	Final Exam	13thweek	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***-G.B. Arfken, Mathematical Methods for Physicists, 2005.***
Essential References Materials	***-H.W. Wyld, Mathematical Methods for Physics, Perseus Books Publishing, 1999.*** ***-R. Courant, D. Hilbert, Methods of Mathematical Physics, John Wiley and Sons, 1st Edition, 1965.***
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classroomsare equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

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Course Specifications
(Postgraduate Degree)

Course Title:	Modeling and Simulation in Physics
Course Code:	PHY 6233
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**4(3 Lectures, 0 Lab, 2 Tutorial)**			
2. Course type				
a.	University ☐	College ☐	Department ☑	Others ☐
b.	Required ☐	Elective ☑		
3. Level/year at which this course is offered:	**Year 2**			
4.Pre-requisites for this course (if any)**:**	**None**			
5. Co-requisites for this course (if any)**:**	**None**			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course will introduce the solution of physics problems using computers. Assuming no previous computer programming experience, the course will introduce the basic ideas and programming skills of computational physics and students will develop their own computer software to solve problems in quantum mechanics, electromagnetism, biophysics, mechanics, chaos, nonlinear dynamics, and other areas.

2. Course Main Objective

At the end of this course, students will be able to:

- **Select the proper formulation for describing specific physical phenomenon,**
- **Build high quality computer program.**
- **Choose the most accurate numerical techniques adaptable for modeling the physical phenomenon.**

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Interpret the mathematical models for solving selected physical problems of a linear and nonlinear nature and state the dynamic equations of motion concerning linear and nonlinear motion.	K1
1.2	Discuss the equations of the rigid body dynamic.	K1, K2
1.3	Summarize the physical experiment and validate the theory.	K2, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying mathematical modeling in physics.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	Introduction to numerical analysis differential and integral equations for mathematical modeling of physical systems.	12
2	Dynamic motion of physical system, motion of physical system in force free field and force field.	12
3	Motion of rigid body, constraint analysis and equation of motion of rigid body.	12
4	Collision of physical system, analysis in center of mass and lab. frame of reference.	12
5	Physical systems interaction, particle-particle interaction and particle-field interaction, introduction to Maxwell equations.	12
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Define the mathematical models for solving selected physical problems of a linear and nonlinear nature and State the dynamic equations of motion concerning linear and nonlinear motion.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe and solve the equations of the rigid body dynamic	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Describe the physical experiment and validate the theory.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying mathematical modeling in physics.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.…..)	weekly	20 %
2	Midterm Exam 1	4th week	20 %
3	Midterm Exam 2	8th week	20 %
4	Final Exam	12th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	-
Essential References Materials	-K. Erleben, J. Sporring, K. Henriksen, H. Dohlmann, Physics-Based Animation, Charles River Media, 2005. -H. Gould, J. Tobochnik, W. Christian, A. Wesley, An Introduction to Computer Simulation Methods: Applications to Physical Systems, 3rd Edition, 2006.
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• Each of the classrooms should be equipped with a whiteboard and a projector.
Technology Resources (AV, data show, Smart Board, software, etc.)	• Classrooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T15

Course Specifications (Postgraduate Degree)

Course Title:	Symmetry in Physics
Course Code:	PHY 6235
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: **4(3 Lectures, 0 Lab, 2 Tutorial)**	
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☐ Elective ☑	
3. Level/year at which this course is offered: **Year 2**	
4.Pre-requisites for this course (if any)**: None**	
5. Co-requisites for this course (if any)**: None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	60	100%
2	**Blended**		
3	**E-learning**		
4	**Distance learning**		
5	**Other**		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	36
2	**Laboratory/Studio**	0
3	**Tutorial**	24
4	**Others** (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course covers knowledge of broad principles of symmetry groups and gives a deep understanding of symmetry groups and their applications in diverse problems in physics. In addition, it provides mathematical tools needed for the physical symmetry problems.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate knowledge of broad principles of symmetry groups.
- Develop a deep understanding of symmetry groups and their applications in diverse problems in physics.
- Develop the knowledge of mathematical tools needed for the physical symmetry problems.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Interpret the principles of symmetry in physics.	K1
1.2	Suggest and perform a calculation by using mathematical tools.	K1, K2
1.3	Describe the Lie groups and Lie algebras.	K2, K3
2	Skills:	
2.1	Explain the basic knowledge gained from studying symmetry in physics.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	Introduction to symmetries: The idea of Symmetry, Symmetries of the square.	10
2	Mathematical preliminaries : Sets, Maps, and Algebras	10
3	Discrete Groups: Finite groups, Dihedral, Cyclic, Permutation, Symmetric groups. Lagrange's Theorem. Cayley's Theorem.	10
4	Matrix Groups and Representation Theory: Continuous Groups. Matrix groups. Vector Spaces. Representation Theory. Orthogonality Theorem. Schur's Lemmas. Characters.	10
5	Lie Groups and Lie Algebras: Analyticity. Innitisimal generators of Lie Groups. so(3) Lie Algebra	8
6	Application: Rotation Symmetry in Quantum Mechanics, Representations of SO(3) and SU(2). Ladder Operators. Hydrogen Atom.	8
7	Introduction to symmetries: The idea of Symmetry, Symmetries of the square.	4
Total		60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	AssessmentMethods
1.0	**Knowledge and Understanding**		
1.1	State the principles of symmetry in physics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe and perform a calculation by using mathematical tools.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Outline some physical parameters for specific type of symmetries such as rotation symmetry and describe the Lie groups and Lie algebras.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying symmetry in physics.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : • **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.** • **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.** • **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	-
Essential References Materials	***-G. Hooft, M. J. G. Veltman, Lie Groups in Physics, Utrecht University, 2007.*** ***-H. Georgi, Lie Algebras in Particle Physics, Benjamin Cummings, 1982.*** ***-K. Huang, Quarks, Leptons and Gauge Fields, 2nd Edition, World Scientific, 1992.***
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each classroom should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning	• **Instructor** • **Second assessor**	**At the end of each semester the course instructor should**

Evaluation Areas/Issues	Evaluators	Evaluation Methods
outcomes, Quality of learning resources.		**complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T15

Course Specifications
(Postgraduate Degree)

Course Title:	Selected Topics in Physics (1)
Course Code:	PHY 6241
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**4(3 Lectures, 0 Lab, 2 Tutorial)**
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☐ Elective ☑	
3. Level/year at which this course is offered:	**Year 2**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

The feature of this course will be determined according to local national or international economic developments, significant recent research in the field, technological changes affecting skill requirements, employment demand, government policies on higher education or on matters affecting the fields for which students are being prepared, national or international developments in professional practice in the field.

2. Course Main Objective

- Selected Topics in Applied Physics (STAP) will highlight a specific topic in applied physics, which will be selected by the Department council.
- The STAP course will feature rapidly developing current trends in the selected research area or, from a specific viewpoint, topics of interest in applied physics and its related interdisciplines.
- A decision of the selected areas planned for future issues will be decided by the Department Council.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Apply of the fundamental principles to particular areas and outline knowledge of the principles of operations to particular areas.	K1
1.2	Understand the selected subjects with greater depth and learn of its current developments.	K1, K3
1.3	Describe advanced mathematics and its application in physics.	K2, K2
2	**Skills:**	
2.1	Explain and summarize the basic knowledge gained from studying this course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	**Values:**	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	-Upon specifying the course	-
2	-	-
3	-	-
4	-	-
5	-	-
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Apply of the fundamental principles to particular areas and outline knowledge of the principles of operations to particular areas.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Understand the selected subjects with greater depth and learn of its current developments.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Describe advanced mathematics and its application in physics.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Solve problems with well-defined solutions by formulating problems in precise terms, identifying key issues and trying different approaches in order to make progress.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	6th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : • **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.** • **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.** • **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	Upon specifying the course.
Essential References Materials	Upon specifying the course.
Electronic Materials	
Other Learning Materials	

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	Selected Topics in Physics (2)
Course Code:	PHY 6242
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**4(3 Lectures, 0 Lab, 2 Tutorial)**
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☐ Elective ☑	
3. Level/year at which this course is offered:	**Year 2**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

The feature of this course will be determined according to local national or international economic developments, significant recent research in the field, technological changes affecting skill requirements, employment demand, government policies on higher education or on matters affecting the fields for which students are being prepared, national or international developments in professional practice in the field.

2. Course Main Objective

- Selected Topics in Applied Physics (STAP) will highlight a specific topic in applied physics, which will be selected by the Department council.
- The STAP course will feature rapidly developing current trends in the selected research area or, from a specific viewpoint, topics of interest in applied physics and its related interdisciplines.
- A decision of the selected areas planned for future issues will be decided by the Department Council.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Apply of the fundamental principles to particular areas and outline knowledge of the principles of operations to particular areas.	K1
1.2	Understand the selected subjects with greater depth and learn of its current developments.	K1, K3
1.3	Describe advanced mathematics and its application in physics.	K2, K2
2	**Skills:**	
2.1	Explain and summarize the basic knowledge gained from studying this course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	**Values:**	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	Upon specifying the course.	
2		
3		
4		
5		
	Total	60

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Apply of the fundamental principles to particular areas and outline knowledge of the principles of operations to particular areas.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Understand the selected subjects with greater depth and learn of its current developments.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Describe advanced mathematics and its application in physics.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying this course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	Upon specifying the course
Essential References Materials	
Electronic Materials	
Other Learning Materials	

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

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Course Specifications
(Postgraduate Degree)

Course Title:	**Advanced Statistical Mechanics**
Course Code:	**PHY 6251**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours:	**5(4 Lectures, 0 Lab, 2 Tutorial)**
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☑ Elective ☐	
3. Level/year at which this course is offered:	**Level 4/Year 2**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

This course will provide the fundamental concepts in statistical physics and apply this knowledge to solve problems in elementary particles, nuclear, atomic and molecular physics, as well as solids.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate knowledge of fundamental concepts in statistical physics and apply this knowledge to solve problems in elementary particles, nuclear, atomic and molecular physics, as well as solids;
- Find in statistical mechanics a wholly new and counterintuitive way of thinking about the world;
- Develop physical intuition, mathematical reasoning, and problem solving skills;
- Deal with conceptually rich and technically difficult theoretical problems;
- Know how to use the theory to discuss statistical phenomena quantitatively;
- Have learned the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;
- Have experienced the adept application of physics and mathematics to solve real life problems;
- Prepare for the necessarily rigorous sequence in physics.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	**Knowledge and Understanding**	
1.1	Describe the background and main features of the historical development of statistical mechanics.	K1, K2
1.2	Discuss the basic concepts and principles of statistical mechanics.	K1
1.3	Interpret the physical phenomena.	K1,K3
2	**Skills:**	
2.1	Explain and summarize the basic knowledge gained from studying statistical mechanics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S4
3	**Values:**	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	**The Macroscopic View:** Thermodynamics, Thermodynamics variables, Thermodynamics limit, Thermodynamics transformations, Classical ideal gas, First law of thermodynamics, Magnetic systems.	6
2	**Heat and Entropy:** The heat equations, Applications to ideal gas, Carnot cycle, Second law of thermodynamics, Absolute temperature, Temperature as integrating factor, Entropy, Entropy of ideal gas, The limits of thermodynamics.	8
3	**Using Thermodynamics:** The energy equation, Some measurable coefficients, Entropy and loss, The temperature-entropy diagram, Condition for equilibrium, Helmholtz free energy, Gibbs potential, Maxwell relations, Chemical potential.	8
4	**Phase Transpiration:** First–order phase transition, Condition for phase coexistence, Clapeyron equation, van der Waals equation of state, Viral expansion, Critical point, Maxwell construction, Scaling.	8
5	**The Statistical Approach:** The atomic view, Phase space, Distribution function, Ergodic hypothesis, Statistical ensemble, Microcanonical ensemble, The most probable distribution, Lagrange multipliers.	8
6	**Maxwell-Boltzmann Distribution:** Determining the parameters, Pressure of an ideal gas, Equipartition of energy, Distribution of speed, Fluctuations.	4
7	**Transport Phenomena:** Collisionless and hydrodynamics regimes, Navier-Stokes equation.	4
8	**Quantum Statistics:** Thermal wavelength, Identical particles, Occupation numbers, Spin, Fermi statistics, Bose statistics.	4
9	**The Fermi and the Bose Gas:** Fermi energy, Ground state, Fermi temperature, Low-temperature properties, Particles and holes, Electrons in solids, Semiconductors. Photons, Bose enhancement, Phonons, Debye specific heat, electronic specific heat, Conservation of particle number.	8
10	**Bose-Einstein Condensation:** Macroscopic occupation, The condensate, Liquid helium.	4
11	**Canonical and Grand Canonical Ensembles:** Microcanonical ensemble, Classical canonical ensemble, The partition function, Energy fluctuations, Quantum ensemble, Quantum partition function, The particle reservoir, Grand partition function, Photon fluctuations.	4
12	**The Order Parameter:** Broken symmetry, Ising spin model, Ginsburg-Landau theory.	2
13	**Superfluidity:** Condensation wave function, Mean-field theory, Gross–Pitaevsky equation, quantum phase coherence, Superfluid flow, Meissner effect.	2
13	**Stochastic Processes:** Randomness and probability, Binomial distribution, Poisson, Distribution, Gaussian distribution, Central limit theory.	2
15	**Time-series Analysis:** Ensemble of paths, Markov process, Fokker-Planck equation, Langevin equation.	2
	Total	**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Outline the background and main features of the historical development of statistical mechanics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Outline the basic concepts and principles of statistical mechanics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Describe and discuss physical phenomena.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying statistical mechanics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2	**Midterm Exam 1**	**5th week**	**20 %**
3	**Midterm Exam 2**	**9th week**	**20 %**
4	**Final Exam**	**13th week**	**40 %**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : • **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.** • **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.** • **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***-K. Huang, Introduction to Statistical Physics, Taylor & Francis, 2001.***
Essential References Materials	***-F. Mandl, Statistical Physics, 2nd edition, Wiley, 2000.*** ***-W.G.Y. Rosser, An Introduction to Statistical Physics, Wiley, 1982.***
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses**

Evaluation Areas/Issues	Evaluators	Evaluation Methods
		appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

T15

Course Specifications
(Postgraduate Degree)

Course Title:	Advanced Solid-State Physics
Course Code:	PHY 6161
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: **5(4 Lectures, 0 Lab, 2 Tutorial)**	
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☑ Elective ☐	
3. Level/year at which this course is offered: **Level 3/Year 1**	
4.Pre-requisites for this course (if any)**: None**	
5. Co-requisites for this course (if any)**: None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

The aim of this course is to give an extended knowledge of the principles and techniques of solid-state physics. It is at the level of first-year graduate students and will deepen the understanding already gained through the introduction to solid-state physics. Topics covered include the Drude and Sommerfeld models of metal, the determination of crystal structures by X-Ray diffraction and electron levels in a periodic potential. Fundamental theories are introduced and then extended to show the irrelevance to important applications in current-day technology, industry, and research.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate knowledge of fundamental concepts in advanced solid-state physics.
- Illustrate the concepts of free electron gas model, spin-spin interaction, disorder in solids and their applications and the contact phenomena.
- Solve problems in several topics in advanced solid-state physics.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Recognize different aspects of advanced solid state physics and solve related problems.	K1,K2
1.2	Describe and perform simple calculations in different electron model by using Hartree- Fock theory and the spin-spin interaction model concept and its importance in physics.	K1,K3
1.3	Interpret the basic concepts of superconductivity and their applications.	K1, K2
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying solid-state physics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	**The Drude's Theory of Metals:** Basic assumptions of the model, Collision or relaxation times, DC electrical conductivity, Hall effect and magnetoresistance, AC electrical conductivity, Dielectric function and plasma resonance, Thermal conductivity, Thermoelectric effects.	10
2	**The Sommerfeld Theory of Metals:** Fermi-Dirac distribution, Free electrons, Density of allowed wave vectors, Fermi momentum, energy, and temperature, Ground-state energy and bulk modulus, Thermal properties of a free electron gas, Sommerfeld theory of conduction, Wiedemann-Franz law.	10
3	**Crystal Lattice:** Bravais Lattice and primitive vectors, Simple, body-centered, and face-centered cubic lattices, Primitive unit cell, Wigner-Seitz cell, and conventional cell, Crystal structures and lattices with bases, Hexagonal close-packed and diamond structures, Sodium chloride, Cesium chloride, and Zincblende structures.	10

4	**The Reciprocal Lattice:** Definitions and examples, First Brillouin zone, Lattice planes and Miller indices.	**8**
5	**Determination of Crystal Structures by X-Ray Diffraction:** Formulation of Bragg and von Laue, The Laue condition and Ewald's construction, Experimental methods, Geometrical structure factor, Atomic form factor.	**8**
6	**Classification of Bravais Lattice and Crystal Structures:** Symmetry operations and the classification of Bravais lattices, The seven crystal systems and fourteen Bravais lattices, Crystallographic point groups and space groups,Schoenflies and international notations, Examples from elements.	**8**
7	**Electron Levels in a Periodic Potential:** The periodic potential and Bloch's theorem, Born-von Karman boundary condition, A second proof of Bloch's theorem, Crystal momentum, band index, and velocity, The Fermi surface.	**4**
8	**Electrons in a Weak Periodic Potential:** Perturbation theory and weak periodic potentials, Energylevels near a single Bragg plane, Illustration of extended-, reduced-, and repeated-zone schemes in one dimension, Fermi surface and Brillouin zones, Geometrical structure factor, spin-orbit coupling.	**4**
9	**Beyond the Independent Electron Approximation:** The Hartree equations, The Hartree-Foch equations, Correlation, The dielectric function, Fermi liquid theory.	**4**
10	**Classification of Solids:** The spatial distribution of valence electrons, Covalent, molecular, and ionic crystals, The alkali halides, Ionic radii, metals.	**4**
11	**Cohesive Energy:** The noble gases, Ionic crystals, Cohesion in covalent crystals, Cohesion in metals.	**2**
Total		**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	TeachingStrategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Recognize different aspects of advanced solid-state physics and solve related problems.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe and perform simple calculations in different electron model by using Hartree- Fock theory and the spin-spin interaction model concept and its importance in physics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Describe the basic concepts of superconductivity and their applications.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		

Code	Course Learning Outcomes	TeachingStrategies	Assessment Methods
2.1	Explain and summarize the basic knowledge gained from studying Classical mechanics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework. ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2	**Midterm Exam 1**	**5th week**	**20 %**
3	**Midterm Exam 2**	**9th week**	**20 %**
4	**Final Exam**	**13th week**	**40 %**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	*-N.W. Ashcroft, N.D. Mermin, Solid State Physics, Harcourt College Publishers, 1976.*
Essential References Materials	*-P. Phillips, Advanced Solid State Physics, 2nd Edition, Cambridge University Press, 2012.* *-C. Kittel, Introduction to Solid State Physics, 8th Edition, John Wiley and Sons, 2005.* *-L. M. Sander, Advanced Condensed Matter Physics, Cambridge University Press, 2009.*
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students.** • **Second assessor.**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor.** • **Second assessor.**	**At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

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NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Physics of Semiconductors and Devices**
Course Code:	**PHY 6263**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours:	**4(3 Lectures, 0 Lab, 2 Tutorial)**
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☐ Elective ☑	
3. Level/year at which this course is offered:	**Year 2**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides a rigorous foundation of fundamental concepts of semiconductors physics. This course will include: Energy Bands in Semiconductors, Electronic Effects of Doping Impurities, Lattice Vibrations, Charge Carrier Transport Properties, Optical Properties, p-n Junctions, Bipolar Junction Transistor, Metal-Semiconductor Devices.

2. Course Main Objective

At the end of this course, students will be able to:

- Become familiar with semiconductor materials.
- Demonstrate knowledge of fundamental concepts of semiconductors physics.
- Solve problems in semiconductors physics.
- Learn about the most important applications of semiconductors in nanotechnology.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Interpret the electronic band structures, band gaps for the technologically important semiconductors, also describe drift, diffusion and scattering under various temperature and impurity concentrations.	K1, K2
1.2	Describe the concentrations of electron and holes with a given temperature in terms of Fermi energy.	K1, K2
1.3	Discuss the electric transport properties and the optical properties of the bulk materials.	K2, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying the course of physics of semiconductors and devices	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	**Energy Bands in Semiconductors**: Electronic structure, Electrons in periodic structures, Semiconductor band structure, Pseudo-potential and kp method, Doping in semiconductors.	12
2	**Electronic Effects of Doping Impurities**: Effective mass theory, Donor impurities in Si and Ge, Donor impurities in III-V semiconductors, Acceptor impurities.	12
3	**Lattice Vibrations**: Equations of motion, Phonon dispersion curves, Models for calculating phonon dispersion curves, Electron-Phonon interactions.	12
4	**Charge Carrier Transport Properties**: Quasi-classical approach, Carrier mobility for a non degenerate electron gas, Scattering mechanisms, High field transport and hot carrier effects.	12
5	**Optical Properties**: Kramers-Kronig relations, Dielectric function, Joint density of states and van Hove singularities, Direct and indirect absorption edges, Excitons, Emission spectroscopies, Light scattering spectroscopies.	12
	Total	**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Describes the electronic band structures, band gaps for the technologically important semiconductors, also describe drift, diffusion and scattering under various temperature and impurity concentrations.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Record the concentrations of electron and holes with a given temperature in terms of Fermi energy.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	State the electric transport properties and the optical properties of the bulk materials.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying the course of physics of semiconductors and devices.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	- S.M. Sze, Physics of Semiconductor Devices, John Wiley and Sons, 1969.
Essential References Materials	- W.C.J. Magnus, W.J. Schoenmaker, Quantum Transport in Sub-Micron Devices-A theoretical Introduction, Springer, 2002. - J. Davies, The Physics of Low-Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998.
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T15

Course Specifications (Postgraduate Degree)

Course Title:	Nanophysics and Technology
Course Code:	PHY 6265
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	4(3 Lectures, 0 Lab, 2 Tutorial)			
2. Course type				
a.	University ☐	College ☐	Department ☑	Others ☐
b.	Required ☐	Elective ☑		
3. Level/year at which this course is offered:	Year 2			
4.Pre-requisites for this course (if any)**:**	None			
5. Co-requisites for this course (if any)**:**	None			

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course introduces the basic principles of nanophysics and nanosciences allowing working in research and development in nanotechnology. Quantum confinement in nanostructures, techniques used for the preparation and characterization nanostructures and semiconductor nanostructures will be developed.

2. Course Main Objective

At the end of this course, students will be able to:

- **Know some important applications in nanotechnology and understand the reason of the researchers' interest on this technology.**
- **Gain an understanding of the historical importance of the development of the nanotechnology and its limitations.**
- **Understand the emerging science of working and building at near the molecular level.**
- **Be familiar with new strategic materials promising in the near future for nanotechnology;**
- **Explain physical properties when the dimensions of the material are small enough to be comparable to the wavelength of the electrons confined inside. The wave nature of the electrons leads to radically altered electronic properties.**
- **Understand the fundamental concepts and the principles through a broad range of interesting applications in nanotechnology;**
- **Have the opportunity to understand the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications;**
- **Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain.**

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	**Describe the background and main features of the historical development of nanophysics and nanotechnology and their limitations.**	**K1,K2**
1.2	**Discuss the techniques used for the synthesis and the characterization of the nanosystems.**	**K1,K2**
1.3	**Interpret the porosity in the materials: equation of Guswitsch, textural characterization by adsorption-desorption, adsorption isotherms, specific surface area, porous volume and pores distribution.**	**K2,K3**
1.4	**Recognize physical phenomena in light of the quantization at different dimensions (3D, 2D, 1D and 0D) and also the effective energy band-gap.**	**K1, K3**
2	Skills:	
2.1	**Explain and summarize the basic knowledge gained from studying Nanophysics and Technology course.**	**S1, S2**
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4**
3	Values:	

CLOs After successful completion of the course, students will able to:		Aligned PLOs
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**

C. Course Content

No	List of Topics	Contact Hours
1	**Generalities on Nanoscience and Nanotechnology:** History of nanosciences, Fundamental concepts (bottom-up and top-down), Importance of nanosystems, Specific surface area and quantization.	**10**
2	**Synthesis Techniques of Nanomaterials:** Introduction on nanofabrication, Generalities on germination techniques, Chemical methods like reduction of metallic salts, Electrochemical reduction, Sol-gel technique, Solvothermal technique, Core-schell systems and in-situ synthesis, Physical methods like thermal evaporation, PLD, electric discharge, Sputtering, MBE, CVD, MOCVD and lithography.	**12**
3	**Quantization (3D, 2D, 1D and 0D):** Gas of free electron, Energy levels for free electron, Energy densities in 3D, 2D, 1D and 0D. Bohr radius, Effective energy band-gap.	**10**
4	**Porosity and Texture of Nanomaterials:** Porous material, Equation of Guswitsch, Textural characterization by adsorption-desorption, Adsorption isotherms, Specific surface area, Porous volume and pores distribution.	**10**
5	**Characterization Techniques of Nanomaterilas:** Structural, textural, Optical, electrical and magnetic characterization techniques generally used for nanosystems study.	**9**
6	**Some Technological Applications:** Nanoelectronic components. Quantum effects in opto-electronic materials and photocatalytic processes. The underlying quantum effects are discussed, as well as recent developments. In addition, fundamental processes in nanostructured semiconductors, such as used in novel, sensitized solar-cells will be discussed.	**9**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Define a broad range of phenomena in nanoscience and describe the background and main features of the historical development of nanophysics and nanotechnology and their limitations.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe the techniques used for the synthesis and the characterization of the nanosystems.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Describe the porosity in the materials: equation of Guswitsch, textural characterization by adsorption-desorption, adsorption isotherms, specific surface area, porous volume and pores distribution.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	State and discuss physical phenomena in light of the quantization at different dimensions (3D, 2D, 1D and 0D) and also the effective energy band-gap.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying the course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	-
Essential References Materials	*-Modern Concepts in Nanoscience, 2nd Edition, Wiley-VCH Verlag GmbH & Co. KGaA, 2006.* *C. Binns, Introduction to Nanoscience and Nanotechnology, John Wiley & Sons, 2010.* *-G. Cao, Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, 2nd Edition; World Scientific, 2011.*
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• Each of the class room should be equipped with a whiteboard and a projector.
Technology Resources (AV, data show, Smart Board, software, etc.)	• Classrooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	Physics of Low-Dimensional Systems
Course Code:	PHY 6267
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours: **4(3 Lectures, 0 Lab, 2 Tutorial)**				
2. Course type				
a.	University ☐	College ☐	Department ☑	Others ☐
b.	Required ☐	Elective ☑		
3. Level/year at which this course is offered: **Year 2**				
4.Pre-requisites for this course (if any)**: None**				
5. Co-requisites for this course (if any)**: None**				

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides a rigorous foundation of Physics of Low-Dimensional Systems. This course will include: Technological Applications, Synthesis, Quantum Size Effect, Electrical and Optical Properties, Modern Heterostructures at Low Dimensions.

2. Course Main Objective

At the end of this course, students will be able to:

- **Explain physical properties when the dimensions of the material are small enough to be comparable to the wavelength of the electrons confined inside. The wave nature of the electrons leads to radically altered electronic properties.**
- **Understand the emerging science of working and building at near the molecular level.**
- **Be familiar with new strategic materials promising in the near future for nanotechnology;**
- **Know some important applications in nanotechnology and understand the reason of the researchers interest on this technology;**
- **Understand the fundamental concepts and the principles through a broad range of interesting applications in nanotechnology;**
- **Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain;**
- **Understand the techniques to solve, through discussion and reading, a wide range of specific theoretical problems, including their backgrounds and implications.**

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Recognize the basics of low-dimensional systems: two, one and zero dimensional nanostructures.	K1, K2
1.2	Explain the development of nanophysics and nanotechnology.	K1, K2
1.3	Interpret the techniques used for the synthesis and the characterization of the low-dimensional systems.	K2, K3
1.4	Describe the quantum size effect, electronic configuration, size effect in metal and semiconductor, required size for size effect.	K1, K2
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying Physics of Low-Dimensional Systems course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	**Generalities**: Introduction into the basics of low-dimensional systems: two, one and zero dimensional nanostructures.	10
2	**Technological Applications**: The importance of such systems for modern physics and present day technology (e.g. micro-electronics, nano-electronics and opto-electronics) will be explained.	10
3	**Synthesis**: Especially lithography of low dimensional systems like two dimensional systems, Quantum wires and quantum dots and Nanocomposites.	10
4	**Quantum Size Effect**: Electronic configuration, Size effect in metal and semiconductor, required size for size effect.	10
5	**Electrical and Optical Properties**: Theory of carrier transport in semiconductors, Boltzmann equation, ballistic transport, Diffusion theory and tunneling effect and mesoscopic physics of light.	10
6	**Modern Heterostructures at Low Dimensions**: The modern heterostructures at low dimensions, including quantum wells, quantum wires, and quantum dots, together with their applications will be discussed. From this course, the students will appreciate how the fundamental courses of Quantum Mechanics and Solid State Physics are applied to the technologically important semiconductor materials, which leads to today's information revolution.	10
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Define the basics of low-dimensional systems: two, one and zero dimensional nanostructures.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe the development of nanophysics and nanotechnology.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	List the techniques used for the synthesis and the characterization of the low-dimensional systems.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Describe the quantum size effect, electronic configuration, size effect in metal and semiconductor, required size for size effect.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying Physics of Low-Dimensional Systems course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in	• Problem classes and group tutorial.	▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	physics related the topics covered by the course.	• Homework assignments as well as problems solutions.	
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc......)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	-
Essential References Materials	-M.J. Kelly, Low-dimensional semiconductors: Materials, Physics, Technology, Devices, Clarendon Press, Oxford, 1995. -J.L. Morán-López, Physics of Low Dimensional Systems, Springer, 2001.

	-Y. Imry, Introduction to Mesoscopic Physics, Oxford University Press, 1997. -T. Ando, Mesoscopic Physics and Electronics, Springer-Verlag, Berlin, 1998.
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• Each of the classrooms should be equipped with a whiteboard and a projector.
Technology Resources (AV, data show, Smart Board, software, etc.)	• Classrooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA T15

Course Specifications (Postgraduate Degree)

Course Title:	Advanced Nuclear Physics
Course Code:	PHY 6171
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**5(4 Lectures, 0 Lab, 2 Tutorial)**
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☑ Elective ☐	
3. Level/year at which this course is offered:	**Level 3/Year 1**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

This course introduces basics of nuclear physics, including nuclear decays and reactions and nuclear structure. It also covers the essential areas of basic research and practical applications with emphasis on phenomenology and the results of real experiments. Discussions of theory are reinforced with examples, which illustrate and apply the theoretical formulism. As an advanced course in Nuclear Physics, it allows for an extended and more in-depth presentation of the major scientific and technological advances in modern day research both in nuclear physics and astrophysics.

2. Course Main Objective
At the end of this course, students will be able to: • Understand the theoretical properties of the nucleus, nuclear force, structure and models. • Evaluate nuclear conserved quantities, symmetries, spin and magnetic moment. • Understanding the nuclear transformations, radioactive decay and Fermi theory of beta decay. • Learn the basic principles of neutron cross sections, Kinematics of elastic scattering. • Gain a thorough understanding of angular and energy distributions, nuclear reaction energetic, compound nucleus models.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Interpret the concepts of nuclear physics and their governing laws.	K1
1.2	Describe the background and main features of physical properties of the nucleus, nuclear force, structure and models, conserved quantities, symmetries, spin and magnetic moment, electric quadruple moment, nuclear.	K1,K3
1.3	Explain the historical importance of scattering, ground state of the deuteron, s-wave n-p scattering, nuclear transformations, bound states.	K1,K2
1.4	Discuss physical phenomena kinematics of elastic scattering, angular and energy distributions, nuclear reaction energetic, compound nucleus model.	K1
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying nuclear physics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	**Basic Concepts:** History and overview, Some introductory Terminology, Nuclear properties, Units and dimensions.	4
2	**Elements of Quantum Mechanics:** Quantum behavior, Principles of quantum mechanics, Problems in one dimension, Problems in three dimensions, Quantum theory of angular momentum, Parity, Quantum statistics, Transitions between states.	8

3	**Nuclear Properties:** Nuclear radius, Mass & abundance of nuclides, Nuclear binding energy, Nuclear angular momentum, Parity, Nuclear electromagnetic moments.	**8**
4	**Nuclear Models:** The shell model, Even-Z, Even-N nuclei and collective structure, More realistic nuclear models.	**8**
5	**Radioactive Decay:** The radioactive decay law, Production and decay of radioactivity, Growth of daughter activities, Types of decays, Natural radioactivity, Radioactive dating, Units for measuring radiation.	**8**
6	**Alpha Decay:** Why alpha decay occurs, Basic alpha decay processes, Alpha decay systematic, Angular momentum and parity in alpha decay.	**6**
7	**Beta Decay:** Energy release in β decay, The "classical" experimental tests of the Fermi theory, Angular momentum & parity selection rules, Comparative half-lives & forbidden decays.	**6**
8	**Gamma Decay:** Energetic of gamma decay, Classical electromagnetic radiation, Angular momentum and parity selection rules, Angular distribution and polarization measurements, Internal conversion, Lifetimes for gamma emission.	**6**
9	**Nuclear Reactions:** Types of reactions and conservation laws, Energetic of nuclear reactions, Isospin, Reactions cross sections, Experimental techniques, Coulomb scattering, Nuclear scattering, Compound-nucleus reactions, Direct reactions.	**6**
10	**Nuclear Fission:** Why nuclei fission, Characteristics of fission, Energy in fission, Controlled fission reactions, Fission reactors, Fission explosives.	**6**
11	**Nuclear Fusion:** Basic fusion processes, Characteristics of fusion, controlled fusion reactions, Thermonuclear weapons.	**6**
Total		**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	State the concepts of nuclear physics and their governing laws.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe the background and main features of physical properties of the nucleus, nuclear force, structure and models, conserved quantities, symmetries, spin and magnetic moment, electric quadruple moment, nuclear.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Outline the historical importance of scattering, ground state of the deuteron, s-wave n-p scattering, nuclear transformations, bound states.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.4	Describe and discuss physical phenomena kinematics of elastic scattering, angular and energy distributions, nuclear reaction energetic, compound nucleus model.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying nuclear physics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2	**Midterm Exam 1**	**5th week**	**20 %**
3	**Midterm Exam 2**	**9th week**	**20 %**
4	**Final Exam**	**13th week**	**40 %**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : • **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.** • **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.** • **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	***-K.S. Krane, Introductory Nuclear Physics, Wiley, 1988.***
Essential References Materials	***-W.E. Burcham, M. Jobes, Nuclear and Particle Physics, 2nd Edition, John Wiley & Sons Inc, 1995.*** ***-R.D. Evans, The Atomic Nucleus, McGraw-Hill Publishing Company Ltd, 1955.*** ***-A. Guran, M. Cloud, W.B. Zimmerman, The Quantum World of Nuclear Physics, World Scientific, 2005.***
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning	• **Instructor** • **Second assessor**	**At the end of each semester the course instructor should**

Evaluation Areas/Issues	Evaluators	Evaluation Methods
outcomes, Quality of learning resources.		**complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Radiation Detection and Measurements**
Course Code:	**PHY 6273**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours:	4(3 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☐ Elective ☑	
3. Level/year at which this course is offered:	Year 2
4.Pre-requisites for this course (if any)**:**	None
5. Co-requisites for this course (if any)**:**	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course is intended to develop and apply the Lagrangian and Hamiltonian mechanics to systems with constraints, rigid body dynamics, vibrations, central forces, and continuous systems. The emphasis is on the canonical structure of classical mechanics, in which the parallels to quantum mechanics are most transparent. The course starts with Hamilton's principle of least action to derive Lagrange's equations, and applies the formalism to dynamical systems with constraints. Conservation of energy, momentum, and angular momentum are linked to symmetry principles. Canonical transformation theory is also discussed with applications to rigid body motion, including the dynamics of tops.

2. Course Main Objective

At the end of this course, students will be able to:

- Demonstrate and understand the principles of radiation detection and measurement in nuclear instruments;
- Understand the theory, design, and operation of the most common radiation detection instruments.
- Evaluate and compare the radiation instrumentation methods.
- Gain knowledge and skills on radiation detection, counting and spectrometry including shielding and health physics;
- Develop a working knowledge of error analysis and statistical methodology to be used in the design of experiments and the quantification of radioactivity.
- Understand the applicability and limitations of all major types of detectors.
- Demonstrate an ability to conduct experiments and understanding how to acquire, identify, quantify and assess radionuclides and report radiation data, uncertainty and detection limits.
- Gain a thorough understanding of gamma and neutron spectroscopy and the systems used in multichannel analysis.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Describe the naturally occurring radioisotopes, physical phenomena.	K1
1.2	Interpret the principles of radiation detection and measurement in nuclear spectroscopy	K1, K2
1.3	Define the applicability and limitations of all major types of detectors.	K1, K3
1.4	Discuss the neutron interaction with matter and how can it detected.	K1, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying radiation detection and measurement.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	**General Properties of Radiation Detectors: Simplified detector model, Models of detector operation, Pulse height spectra, Counting curves and plateaus, Energy resolution, Detection efficiency, Dead time.**	**8**
2	**Ionization Chambers: The ionization process in gases, Charge migration and collection, Design and operation of DC ion chambers, Pulse mode operation.**	**8**
3	**Proportional Counters: Gas multiplication, Design features of proportional counters, Proportional counter performance, Detection efficiency and counting curves, Variants of the proportional counter design.**	**8**
4	**Geiger-Mueller counters: The Geiger discharge, Fill gases, Quenching, Time behavior, The Geiger counting plateau, Design features, Counting efficiency, Time-to-first count method, G-M survey meters.**	**8**
5	**Scintillation Detectors: Organic scintillators, Inorganic scintillators, Light collection and scintillator mounting.**	**6**
6	**Photomultiplier Tubes and Photodiodes: The photocathode, Electron Multiplication, Photomultiplier tube characteristics, Photodiodes as substitutes for photomultiplier tubes, Scintillation pulse shape analysis, Photoionization detectors.**	**6**
7	**Semiconductor Diode Detectors: General consideration in gamma-ray spectroscopy, Gamma-ray interactions, Properties of scintillation gamma-ray spectrometers.**	**6**
8	**Germanium Gamma-Ray Detectors: General consideration, Configuration of germanium detectors, Germanium detector operational characteristics, Gamma-ray spectroscopy with germanium detectors.**	**6**
9	**Neutron Detection and Spectroscopy: Nuclear reactions of interest in neutron detection, Detectors based on the boron reaction, Detectors based on other conversion reactions.**	**4**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Describe the naturally occurring radioisotopes, physical phenomena.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe the principles of radiation detection and measurement in nuclear spectroscopy	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Define the applicability and limitations of all major types of detectors. How we can choose the suitable detector for a special measurement?	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Describe the neutron interaction with matter and how can it detected.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying radiation detection and measurement.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	*-G.F. Knoll, Radiation Detection and Measurement, 4th Edition, John Wiley & Sons, 2012*
Essential References Materials	*-E.J. Turner, Atoms, Radiation, and Radiation Protection, 3rd Edition, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2007.* *-G.R. Gilmore, Practical Gamma-ray Spectrometry, 2nd Edition, John Wiley & Sons, Ltd., 2008.*
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)

Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)

Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

T15

Course Specifications (Postgraduate Degree)

Course Title:	Radiological Mathematics
Course Code:	PHY 6275
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**4(3 Lectures, 0 Lab, 2 Tutorial)**
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☐ Elective ☑	
3. Level/year at which this course is offered:	**Year 2**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course is intended to develop and apply the measurement related to Radiation Physics, Nature of Counting Distributions, Binomial Distribution, Poisson Distribution, Normal Distribution, Mean and Standard Deviation of a Set of Measurements. The course starts with Units of measurement and Detection and Uncertainty for Gamma Spectroscopy and discussed the levels of Detection, Critical Level, Detection Limit (Ld) or Lower Level of Detection (LLD), Minimum Detectable Concentration or Contamination, Minimum Detectable Concentration (MDConc.), Minimum Detectable Contamination (MDCont.), Less-than Level (Lt), Interpretations and Restrictions, Log Normal Data Distributions, Particle Size Analysis.

2. Course Main Objective
At the end of this course, students will be able to: • Learn and understand the statistical world of atoms and radiation. • Become familiar with methods or radiation measurement. • Understand and apply counting statistics models and error propagation. • Learn to calculate detection limits and other quantities related to radiation measurements, radiation exposure and perform associated risk analysis. • Learn about the methods and approaches for implementation of a radiation protection program.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Define probabilities and rates in radiation physics.	K1
1.2	Describe the statistics in radiation physics.	K1, K2
1.3	Outline the methods of radiation measurement.	K2, K3
1.4	Describe the counting statistics models and error propagation.	K1, K2
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying Radiological Mathematics course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	Units of measurement related to Radiation Physics, Nature of Counting Distributions, Binomial Distribution, Poisson Distribution, Normal Distribution, Mean and Standard Deviation of a Set of Measurements.	12
2	Uncertainty in the Activity of a Radioactive Source, Uncertainty in a Single Measurement, Propagation of Error.	12
3	Statistical Subtraction of a Background Count or Count Rate, Error Propagation of Several Uncertain Parameters, Comparison of Data Sets, Are Two Measurements Different, Statistics for the Counting Laboratory, Uncertainty of a Radioactivity Measurement, Determining a Count Time, Efficient Distribution of Counting Time.	12
4	Detection and Uncertainty for Gamma Spectroscopy, Testing the Distribution of a Series of Counts, the Chi-square Statistic, Weighted Sample Mean, Rejection of Data.	12
5	Levels of Detection, Critical Level, Detection Limit (Ld) or Lower Level of Detection (LLD), Minimum Detectable Concentration or	12

	Contamination, Minimum Detectable Concentration (MDConc.), Minimum Detectable Contamination (MDCont.), Less-than Level (Lt), Interpretations and Restrictions, Log Normal Data Distributions, Particle Size Analysis.	
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Interpret probabilities and rates in radiation physics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Describe the statistics in radiation physics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Discuss the methods of radiation measurement.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Describe the counting statistics models and error propagation.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying Radiological Mathematics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.…..)	weekly	20 %
2	Midterm Exam 1	5thweek	20 %
3	Midterm Exam 2	9thweek	20 %
4	Final Exam	13thweek	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	-
Essential References Materials	*-J.E. Martin, Physics for Radiation Protection, 2nd Edition, Wiely-VCH, 2006.* *-J.E. Turner, Atoms, Radiation, and Radiation Protection, 3rd Edition, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2007.* *-G.F. Knoll. Radiation Detection and Measurement, 4th Edition, John Wiley & Sons, 2012*
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد
NCAAA
T15

Course Specifications
(Postgraduate Degree)

Course Title:	**Radiation Protection and Dosimetry**
Course Code:	**PHY 6277**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **4(3 Lectures, 0 Lab, 2 Tutorial)**	
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☐ Elective ☑	
3. Level/year at which this course is offered: **Year 2**	
4.Pre-requisites for this course (if any)**: None**	
5. Co-requisites for this course (if any)**: None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	36
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	60

B. Course Objectives and Learning Outcomes

1. Course Description

This course offers professionals and advanced students a comprehensive coverage of the principal concepts upon which radiation protection and dosimetry are based and presents methods for their practical utilization and calculations. Basic principles and procedures that are used in radiation dosimetry, radiation shielding and radiation protection are illustrated with an abundance of worked examples that exemplify practical applications and statistical interpretations.

2. Course Main Objective

At the end of this course, students will be able to:

- Understand the physical, chemical and biological effects of radiation.
- Learn the radiation protection standards, guidelines and recommendations.
- Become familiar with the type of instrumentation used in radiation measurement and protection.
- Understand the elements of radiation exposure, protection and shielding.
- Differentiate between various radiation sources, exposure, pathways and their related risks.
- Learn to calculate radiation exposure and perform associated risk analysis.
- Learn about the methods and approaches for implementation of a radiation protection program.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Discuss the concepts of atomic and nuclear physics for radiation protection and dosimetry.	K1
1.2	Describe the interaction of ionizing radiation and neutrons with matter and ability to apply this knowledge to practical problems.	K1, K2
1.3	Interpret the concepts of external radiation dosimetry.	K1
1.4	Recognize the concepts of internal radiation dosimetry to practical problems.	K2, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying Radiation Protection and Dosimetry	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	Radiation Dosimetry: Quantities and units, Exposure, Absorbed dose, Dose equivalent, Measurement of exposure, Free-air ionization chamber, The air-wall chamber, Measurement of absorbed dose, Measurement of x- and gamma-ray dose, Neutron dosimetry, Dose measurements for charged-particle beams, Determination of LET, Dose calculations, Alpha and low-energy Beta emitters distributed in tissue, Charged-particle beams, Point source of gamma rays, Neutrons, Other dosimetricconcepts and quantities, Kerma, Microdosimetry, Specific energy, Lineal energy.	12
2	Chemical and Biological Effects of Radiation: Time frame for radiation effects, Physical and prechemicalchances in irradiated water, Chemical	12

	stage, Examples of calculated charged-particle tracks in water, Chemical yields in water, Biological effects, Sources of human data, The life span study, Medical radiation, Radium-dial painters, Uranium miners, Accidents, The acute radiation syndrome, Delayed somatic effects, Cancer, Life shortening, Cataracts, Irradiation of mammalian embryo and fetus, Genetic effects, Radiation biology, Dose–response relationships, Factors affecting dose response, Relative biological effectiveness, Dose rate, Oxygen enhancement ratio, Chemical modifiers, Dose fractionation and radiotherapy.	
3	**Radiation-Protection Criteria and Exposure Limits: Objective of radiation protection, Elements of radiation-protection programs, The NCRP and ICRP, NCRP/ICRP dosimetricquantities, Equivalent dose, Effective dose, Committed equivalent dose, Committed effective dose, Collective quantities, Limits on intake, Risk estimates for radiation protection, Current exposure limits of the NCRP and ICRP, Occupational limits, Nonoccupational limits, Negligible individual dose, Exposure of individuals under 18 years of age, Occupational limits in the dose-equivalent system, The "2007 ICRP recommendations", ICRU operational quantities, Probability of causation.**	**12**
4	**External Radiation Protection: Distance, Time and shielding, Gamma-ray shielding, Shielding in X-Ray installations, Design of primary protective barrier, Design of secondary protective barrier, NCRP report No. 147, Protection from beta radiation, Neutron shielding.**	**12**
5	**Internal Dosimetry and Radiation Protection: ICRP publication 89, Methodology, ICRP-30 dosimetricmodel for the respiratory system, ICRP-66 human respiratory tract model, ICRP-30 dosimetricmodel for the gastrointestinal tract, Organ activities as functions of time, Specific absorbed fraction, Specific effective energy and committed quantities, Number of transformations in source organs over 50 Y, Dosimetricmodel for bone, ICRP-30 dosimetricmodel for submersion in a radioactive gas cloud, Selected ICRP-30 metabolic data for reference man.**	**12**
Total		**60**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Explain and summarize the basic knowledge gained from studying Radiation Protection and Dosimetry	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Explain and summarize the basic knowledge gained from studying Radiation Protection and Dosimetry	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying Radiation Protection and Dosimetry.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework. ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc......)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	
Essential References Materials	*-J. E. Turner, Atoms, Radiation, and Radiation Protection, 3rd Edition, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2007.* *-E.B. Podgorsak. Radiation Physics for Medical Physicists, Springer, 2006.* *-J.E. Martin, Physics for Radiation Protection, 2nd Edition, Wiely-VCH, 2006.*
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the class room should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA
T15

Course Specifications (Postgraduate Degree)

Course Title:	**Synthesis and Characterization Techniques**
Course Code:	**PHY 6281**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: **4(1 Lectures, 4 Lab, 2 Tutorial)**	
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☐ Elective ☑	
3. Level/year at which this course is offered: **Year 2**	
4.Pre-requisites for this course (if any)**: None**	
5. Co-requisites for this course (if any)**:None**	

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	84	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	12
2	Laboratory/Studio	48
3	Tutorial	24
4	Others (specify)	0
	Total	84

B. Course Objectives and Learning Outcomes

1. Course Description

This course introduces the techniques used for the synthesis and the characterization of the nano-systems. Moreover, it provides the development of the nanotechnology and its limitations.

2. Course Main Objective

At the end of this course, students will be able to:

- Be familiar with nanoscience techniques for synthesis and characterization.
- Use very sophistic techniques for the characterization of advanced materials.
- Practice in writing reports from minor experimental research projects;
- Gain an understanding of the importance of the development of the nanotechnology and its limitations.
- Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain.
- Know some important applications in nanotechnology and understand the reason of the researchers interest on this technology.
- Understand the emerging science of working and building at near the molecular level.
- Be familiar with new strategic materials promising in the near future for nanotechnology.
- Explain physical properties when the dimensions of the material are small enough to be comparable to the wavelength of the electrons confined inside. The wave nature of the electrons leads to radically altered electronic properties.
- Understand the fundamental concepts and the principles through a broad range of interesting applications in nanotechnology.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	Describe the techniques used for the synthesis and the characterization of the nano systems.	K1, K2, K3
1.2	Discuss the importance of the development of the nanotechnology and its limitations.	K1, K2, K3
1.3	Interpret the broad range of phenomena in nanophysics and nanotechnology.	K1, K2, K3
1.4	Describe the porosity in the materials: specific surface area, porous volume and pores distribution.	K1, K2, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying Synthesis and Characterization Techniques course.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	**Synthesis Techniques:** Synthesis of nanoparticles by sol-gel, ball milling and solve-thermal techniques. Thin film and heterostructure deposition techniques (MBE, PLD, PCVD and sputtering). Nanocomposites by thermal reaction technique.	32
2	**Structural and Textural Characterizations:** Scanning electron microscopy (SEM). Transmission electron microscopy (TEM). X-ray diffraction (XRD). Atomic force microscopy (AFM). Porosimeter.	26
3	**Optical, Electric and Magnetic characterization Techniques:** Optical absorption, transmission and reflectance. Photoluminescence and Electroluminescence, Electric and magnetic characterizations: I(V) technique, Impedance at different frequency and temperature. Hall effect measurement. VSM technique.	26
	Total	**84**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Describe the techniques used for the synthesis and the characterization of the nano systems.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Name the importance of the development of the nanotechnology and its limitations.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Outline the broad range of phenomena in nanophysics and nanotechnology.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Describe the porosity in the materials: specific surface area, porous volume and pores distribution.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying Synthesis and Characterization Techniques course.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and	• Lectures. • Class discussions.	▪ Exams.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	using IT for acquiring and analyzing information.	• Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2	**Midterm Exam 1**	**5th week**	**20 %**
3	**Midterm Exam 2**	**9th week**	**20 %**
4	**Final Exam**	**13th week**	**40 %**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	
Essential References Materials	**-W. Ashcroft, N.D. Mermin, Solid State Physics, Harcourt College Publishers, 1976.** **-P. Hofmann, Solid State Physics, an Introduction, Wiley-VCH, 2008.** **-M.P. Marder, Condensed Matter Physics, John Wiley & Sons, Inc. 2000.**
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

اعتماد NCAAA

T15

Course Specifications
(Postgraduate Degree)

Course Title:	Experimental Methods in Radiation Physics
Course Code:	PHY 6283
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	**4(1 Lectures, 4 Lab, 2Tutorial)**
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☐ Elective ☑	
3. Level/year at which this course is offered:	**Year 2**
4.Pre-requisites for this course (if any)**:**	**None**
5. Co-requisites for this course (if any)**:**	**None**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	84	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	12
2	Laboratory/Studio	48
3	Tutorial	24
4	Others (specify)	0
	Total	84

B. Course Objectives and Learning Outcomes

1. Course Description

This course provides the basic concepts of the instruments and techniques important in the detection and spectroscopy of ionizing radiation, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical analysis.

2. Course Main Objective

At the end of this course, students will be able to:

- Understanding of the instruments and techniques important in the detection and spectroscopy of ionizing radiation.
- Evaluate and compare the radiation instrumentation methods.
- Improve the ability to evaluate measurement systems for different applications.
- Understand the applicability and limitations of all major types of detectors.
- Gain a thorough understanding of gamma and neutron spectroscopy and the systems used in multichannel analysis.
- Describe the laboratory experiments concisely present and analyze results, including experimental, calculated, and propagated uncertainties, and draw conclusions based on the results, and make oral presentations to the class.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	State the techniques applicable to their own research experiment in Radiation detection and/or instrumentation.	K1,K3
1.2	Describe and interpret experimental data pertaining to radiation detection.	K1, K2
1.3	State the fundamental processes involved with the interaction of X- and gamma-ray photons, charged particles and neutrons with matter.	K1,K2
1.4	Describe the basic evaluation of experimental data using standard statistical methods.	K2, K3
2	Skills:	
2.1	Explain and summarize the basic knowledge gained from studying Experimental Methods in Radiation Physics.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3

C. Course Content

No	List of Topics	Contact Hours
1	Determination of half-value thickness and linear attenuation coefficient of porous media. Verification of inverse square law.	10
2	Determination of plateau and resolving time of a GM counter and its application in measurement of beta source activity. Study the range of beta particles measurement.	10
3	Study of voltage and current characteristics of an ion chamber.	10
4	Calibration check of survey instrument and pocket dosimeters. Statistics of radioactive counting.	10
5	Calibration TL phosphor & TLD reader and its use in dose distribution measurements. Calibration of TLD personnel monitoring badge, dose evaluation and risk estimate.	10
6	Characteristics of a flow counter and beta activity measurement.	10
7	Determination of percentage depth dose of high energy photon beams and electron beams.	10
8	Preparation and standardization of sealed sources/unsealed sources. Study of linearity of dose monitoring system of linear accelerator.	8
9	Quality assurance test procedures of radiation physics.	6
Total		84

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Discuss the techniques applicable to their own research experiment in Radiation detection and/or instrumentation.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Interpret experimental data pertaining to radiation detection.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Recognize the fundamental processes involved with the interaction of X- and gamma-ray photons, charged particles and neutrons with matter.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Describe the basic evaluation of experimental data using standard statistical methods.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying Experimental Methods in Radiation Physics.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**20 %**
2	**Midterm Exam 1**	**5th week**	**20 %**
3	**Midterm Exam 2**	**9th week**	**20 %**
4	**Final Exam**	**13th week**	**40 %**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor to give them the appropriate academic counseling and support.**
- **The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule.**
- **Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	
Essential References Materials	**-G.F. Knoll. Radiation Detection and Measurement, 4th Edition, John Wiley & Sons, 2012.** **-G.R. Gilmore, Practical Gamma-ray Spectrometry, 2nd Edition, John Wiley & Sons, Ltd., 2008.**
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	**Multimedia associated with the textbook and the relevant websites.**

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• **Each of the classrooms should be equipped with a whiteboard and a projector.**
Technology Resources (AV, data show, Smart Board, software, etc.)	• **Classrooms are equipped with data show and Smart Board.**
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Quality Unit-Physics Department**
Reference No.	**Department council No. 11**
Date	**16/11/2022**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

Course Specifications
(Postgraduate Degree)

Course Title:	**Research Project**
Course Code:	**PHY 6299**
Program:	**Master of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**

Table of Contents

A. Course Identification

1. Credit hours: 4 (2 Lectures, 2 Lab, 2 Tutorial)							
2. Course type							
a.	University ☐	College ☐	Department ☑	Others ☐			
b.	Required ☑	Elective ☐					
3. Level/year at which this course is offered: Level 6/Year 2							
4.Pre-requisites for this course (if any)**:** None							
5. Co-requisites for this course (if any)**:** None							

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	24
2	Laboratory/Studio	24
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

To demonstrate a student's work ethic, level of initiative, determination and approach to problem solving, give an early indication of a physicist's project management skills, as each student is largely responsible for their own programme of work, test of general physics ability and plan and carry out a detailed and original piece of scientific research and communicate the results.

2. Course Main Objective

At the end of this course, students will be able to:

- Make bibliography about the current state of the art of specific scientific subjects;
- Able to reed, comment and summarize scientific papers;
- Be adept for the development of innovative ideas in the research;
- Gain an understanding of the importance of the development of the science in specific problem and its limitations.
- Be adept at the application of physical and mathematical tools to solve real life problems in the considered domain;
- Know some important applications in the technology and understand the reason of the researchers interest on this field;
- Be familiar with new strategic ideas promising in the near future for scientific community;
- Understand the fundamental concepts and the principles of specific physical problem through a broad range of interesting applications in technology;
- Practice in writing reports from research works.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	List the bibliography about specific scientific subject using different international scientific sources.	K1
1.2	Interpret the technological development in a specific scientific topic.	K1,K3
1.3	Describe broad range of phenomena in physics.	K2, K3
2	Skills:	
2.1	List the bibliography about specific scientific subject using different scientific sources.	S1, S2
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	S2, S3
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	S3, S4
3	Values:	
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	V1, V2,V3
3.2	Self-evaluate of the level of learning and performance, insist on achievement and excellence, and make logical decisions supported by evidence and arguments independently.	V2, V3

C. Course Content

No	List of Topics	Contact Hours
1	Bibliography	15
2	Experimental measurements and/or theoretical work.	42
3	Writing of the final report	15
	Total	**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	List the bibliography about specific scientific subject using different international scientific sources.	• Lectures. • Office hours. • Class discussions.	▪ Participation. ▪ Discussions.
1.2	Name some fundamental courses to explain some real phenomena.	• Lectures. • Office hours. • Class discussions.	▪ Participation. ▪ Discussions
1.3	Define the importance of the development of the technology in specific scientific subject.	• Lectures. • Office hours. • Class discussions.	▪ Participation. ▪ Discussions. ▪
1.4	Define broad range of phenomena in physics.	• Lectures. • Office hours. Class discussions.	▪ Participation. Discussions
2.0	Skills		
2.1	List the bibliography about specific scientific subject using different scientific sources.	• Practical work. • project.	▪ Reports.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Discussion. • Tasks and missions.	▪ Discussions. ▪ Assignments. ▪
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Interactive discussions (special assignments in some courses will require students to search for data and/or information on their own). • Projects. • Use digital library.	▪ Reports. ▪ Presentation.
3.0	**Values**		

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion. • Office hours.	▪ Participation. ▪ Discussion. ▪ Mini-project(s).
3.2	Self-evaluate of the level of learning and performance, insist on achievement and excellence, and make logical decisions supported by evidence and arguments independently.	• Small team tasks • Open discussion. • Office hours.	▪ Reports. ▪ Presentations. ▪ Assignments

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	The final year project is compulsory and 100% based on continuous assessment, i.e. it must be passed at the end semester examinations.	weekly	The final year project is an assessment of performance away from a formal examination
2	1st Report written by supervisor on the advancement of the student's project	5th Week	30 %
3	2nd Report written by supervisor on the advancement of the student's project	10th Week	30 %
4	Final Oral Exam directed by an oral examination committee	13th Week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :

- **Students will be assigned an academic advisor physics postgraduate committee to give them the appropriate academic counseling and support;**
- **The lecturer of this course will allocate 6 office hours per week to help the students in their course;**
- **Student is able to get individual consultation and academic advice appointment with teaching staff via e-mail or phone calls and department website.**

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	-
Essential References Materials	-
Electronic Materials	-
Other Learning Materials	-

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	-
Technology Resources (AV, data show, Smart Board, software, etc.)	-
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• **Students** • **Second assessor**	**During the semester and at the end of the course each student will complete two evaluation forms.**
Extent of achievement of course learning outcomes, Quality of learning resources.	• **Instructor** • **Second assessor**	**At the end of each semester, the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.**

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality oflearning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

T15

Course Specifications
(Postgraduate Degree)

Course Title:	Quantum Mechanics
Course Code:	PHY 6111
Program:	Master of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University

Table of Contents

A. Course Identification

1. Credit hours:	5(4 Lectures, 0 Lab, 2 Tutorial)
2. Course type	
a. University ☐ College ☐ Department ☑ Others ☐	
b. Required ☑ Elective ☐	
3. Level/year at which this course is offered:	Level 2/Year 1
4.Pre-requisites for this course (if any)**:**	None
5. Co-requisites for this course (if any)**:**	None

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	72	100%
2	Blended		
3	E-learning		
4	Distance learning		
5	Other		

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	Lecture	48
2	Laboratory/Studio	0
3	Tutorial	24
4	Others (specify)	0
	Total	72

B. Course Objectives and Learning Outcomes

1. Course Description

This course gives exposure about the various tools employed to analyze the quantum mechanical problems. It introduces Dirac's bra-ket formulation of quantum mechanics and makes students familiar with various approximation methods applied to atomic, nuclear and solid-state physics, as well as adiabatic theorem and Berry's phase and quantum theory of scattering. Finally, relativistic quantum mechanics and Dirac equation will be introduced.

2. Course Main Objective

At the end of this course, students will be able to:

- Know the advanced concepts and applications of quantum mechanics in the area of symmetries, perturbation theory, scattering theory, many-particle systems.
- Know basic concepts of field quantization and relativistic quantum mechanics.

3. Course Learning Outcomes

	CLOs After successful completion of the course, students will able to:	Aligned PLOs
1	Knowledge and Understanding	
1.1	**Describe the background and main features of the historical development of quantum mechanics.**	**K1, K2**
1.2	**State a comprehensive knowledge of the topics covered in the lectures.**	**K1**
1.3	**Outline the advanced topics in quantum mechanics.**	**K1, K3**
2	Skills:	
2.1	**Explain and summarize the basic knowledge gained from studying quantum mechanics course.**	**S1, S2**
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4**
3	Values:	
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**

C. Course Content

No	List of Topics	Contact Hours
1	**Fundamental Concepts:** The Stern-Gerlach experiments, Kets, Bras and operators, Base Kets and matrix representations, Measurements, Observables and the uncertainty relations, changes of basis, Position, Momentum, Translation, Wave Functions in Position and momentum Space.	**12**
2	**Quantum Dynamics:** Time–evolution and the Schrodinger equation, The Schrodinger versus the Heisenberg picture, Simple harmonic Oscillator, The Schrodinger wave equation, Elementary solutions to Schrodinger wave equation, Propagators and Feynmann path integrals, Potentials and gauge transformations.	**12**
3	**Theory of Angular Momentum;** Rotations and angular–momentum commutation relations, Spin ½, Systems and finite rotations, Euler rotations, Density operator, Spin correlation, Tensor operators.	**8**
4	**Symmetry in Quantum Mechanics:** Symmetries, Conservation laws and degeneracies, Discrete symmetries, Parity or space inversion.	**8**
5	**Approximation Methods:** Time independent perturbation theory: Non degenerate and degenerate, Hydrogen like atoms, Time-dependent potentials, Hamiltonian, Time-dependent perturbation theory.	**12**
6	**Scattering Theory:** Scattering as a time–dependent perturbation, The scattering amplitude, The Born approximation, Inelastic electron–atom scattering.	**8**
7	**Identical Particles:** Perturbation symmetry, Summarization postulate, Quantization of the electromagnetic field	**6**

8	**Relativistic Quantum Mechanics:** Paths to relativistic quantum mechanics, The Dirac equation, Symmetries of the Dirac equation, Relativistic quantum field theory.	**6**
Total		**72**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	Describe the background and main features of the historical development of quantum mechanics.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	State a comprehensive knowledge of the topics covered in the lectures.	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Outline the advanced topics in quantum mechanics.	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**		
2.1	Explain and summarize the basic knowledge gained from studying quantum mechanics course.	• Lectures. • Class discussions. • Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	Develop the students ability to solve and analyze problems in physics related the topics covered by the course.	• Problem classes and group tutorial. • Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values**		
3.1	Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation ▪ Homework's ▪ Mini-project(s).

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	Class Activities (class quizzes, homework, solving problems, etc.....)	weekly	20 %
2	Midterm Exam 1	5th week	20 %
3	Midterm Exam 2	9th week	20 %
4	Final Exam	13th week	40 %

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : • Students will be assigned an academic advisor to give them the appropriate academic counseling and support. • The lecturer will allocate 6 office hours per week. The assigned times will be advertised on the office door and reserved by the instructor as part of his teaching schedule. • Students are able to get individual consultation appointment with teaching staff via email, phone calls and department website.

F. Learning Resources and Facilities

1. Learning Resources

Required Textbooks	*-J. J. Sakurai, J.J. Napolitano, Modern Quantum Mechanics, 2nd Edition, Pearson, 2011.*
Essential References Materials	*-R.P. Feynman, R.B. Leighton, M. Sands, The Feynman Lectures on Physics, California, Institute of Technology, 1966.* *-D. McMahon, Quantum Mechanics Demystified, 2nd Edition, McGraw-Hill, 2013.*
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	Multimedia associated with the textbook and the relevant websites.

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	• Each of the class room should be equipped with a whiteboard and a projector.
Technology Resources (AV, data show, Smart Board, software, etc.)	• Classrooms are equipped with data show and Smart Board.
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching and assessment, Quality of learning resources.	• Students • Second assessor	During the semester and at the end of the course each student will complete two evaluation forms.
Extent of achievement of course learning outcomes, Quality of learning resources.	• Instructor • Second assessor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes,Quality of learning resources, etc.)
Evaluators (Students,Faculty, Program Leaders,Peer Reviewer, Others (specify)
Assessment Methods(Direct, Indirect)

H. Specification Approval Data

Council / Committee	Quality Unit-Physics Department
Reference No.	Department council No. 11
Date	16/11/2022