Elective Courses: Bachelor of Science in Physics

Course Name	Course Code
Semiconductor Physics	PHY 1426
Solar Energy	PHY 1427
Fundamental of Photonics	PHY 1440
Laser Physics	PHY 1445
Atomic and Molecular Spectroscopy	PHY 1447
Introduction to Plasma Physics	PHY 1449
Introduction to Radiation Physics	PHY 1469
Special Topics in Applied Physics (1)	PHY 1471
Special Topics in Applied Physics (2)	PHY 1472
Introduction to Nano Physics	PHY 1473
Introduction to Operations Research	MAT 1253

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Course Specification

(Bachelor)

Course Title	**Semiconductor Physics**
Course Code:	**PHY 1426**
Program:	**Bachelor of Science in Physics.**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11 / Year 4)					
4. Course General Description:					
This course provides the basics and principles of semiconductor devices. The major objective is to familiarize the students with the basic principles of operation of modern semiconductor devices such as p-n junction diode, light emitting diodes, JFET transistor, bi-polar transistors, etc.					
5. Pre-requirements for this course (if any):					
Electronics, PHY 1324					
6. Co-requisites for this course (if any):					
7. Course Main Objective(s):					
At the end of this course the student will be able to: • Provide undergraduate students with a wide background and the ability to deal with advanced concepts in semiconductor devices. • Describe the basic devices of semiconductor for the specific application. • Provide the different parameters of semiconductor devices. • Discuss aspects of the effects of semiconductors on the physical science. • Develop critical thinking and analytical problem-solving skills.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		

No	Mode of Instruction	Contact Hours	Percentage
4	Distance learning		

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Outline the basics and principles of semiconductor devices.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. Discussions.
1.2	**Outline the physical insight in the properties of semiconductors.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.3	**Describe the key principles and applications of Semiconductor Physics.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying semiconductor physics course.**	**S1, S2**	▪ 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.**	**S2, S3**	▪ 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**	**S4, S5**	• Lectures. • Class discussions. • Tutorials. • Encourage students	▪ Exams. ▪ Participation and activities of students in the

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	analyzing information.		to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Generalities on Semiconductors:** Introduction presents a summary of the physics and properties of semiconductors, energy bands in semiconductors, electronic structure; electrons in periodic structures, effective mass and semiconductor band gap.	**12**
2.	**Charge Carrier Population:** Intrinsic concentrations; doped semiconductors, N-type and P-type semiconductors, Fermi level at equilibrium.	**10**
3.	**Electrical Conductivity:** Carrier transport phenomena, Quasi-classical approach, carrier mobility for a non-degenerate electron gas, high field transport and hot carrier effects.	**10**
4.	**p-n junction:** Space charge distribution, electronic energy bands in the space charge region; p-n junction under an applied voltage; p-n junction capacitance.	**10**
5.	**Metal-Semiconductor Contacts:** Band structure and electronic properties, metal-semiconductor devices.	**10**
6.	Transistors: Bipolar transistor, JFET transistor	**8**
	Total	**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
2.	Midterm Exam 1	4thweek	25 %
3.	Midterm Exam 2	8thweek	25 %
4.	Final Exam	12thweek	40 %

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Sze S. M., Physics of Semiconductor Devices, Wiley-Interscience (1969).
Supportive References	- Pierret R.F., Semiconductor Device Fundamentals, 2nd Edition (1996). - Yu P.Y., and Cardona M., Fundamentals of Semiconductors, Physics and Materials Properties, 2nd Edition, Springer, Berlin, (1999).
Electronic Materials	https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms. - Labs.
Technology equipment (projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students Second examiner	Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)
Effectiveness of Students assessment	Instructors	Direct (exams, HW, project, ...)
Quality of learning resources	Faculty	indirect (surveys)

Assessment Areas/Issues	Assessor	Assessment Methods
	Students	
The extent to which CLOs have been achieved	Instructors Program Leaders	Direct (excel sheet)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

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Course Specification

(Bachelor)

Course Title	**Solar Energy**
Course Code:	**PHY 1427**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General Description:					
In the solar energy course, you will learn to design a complete photovoltaic system. This course introduces the technology that converts solar energy into electricity, heat and solar fuels with a main focus on electricity generation. Photovoltaic (PV) devices are presented as advanced semiconductor devices that deliver electricity directly from sunlight. This course explores the advantages, limitations and challenges of different solar cell technologies, such as crystalline silicon solar cell technology, thin film solar cell technologies and the latest novel solar cell concepts as studied on lab-scale.					
5. Pre-requirements for this course (if any)**:**					
PHY 1324					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					
• **Give the student a basic knowledge of solar energy.** • **Explain the various concepts to convert solar energy in to electricity, heat and solar fuels.** **Explain the physical working principles of photovoltaic conversion in solar cells.**					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		

No	Mode of Instruction	Contact Hours	Percentage
4	Distance learning		

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the scientific method of inquiry to conclude concepts of solar energy conversion.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. Discussions.
1.2	**Describe the scientific method of inquiry to conclude concepts of photovoltaics.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Outline the scientific method of inquiry to conclude concepts solar cell applications.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**State the scientific method of inquiry to conclude concepts of thin film solar cells.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying waves and optical physics.**	**S1, S2**	▪ Lectures. ▪ Class discussions. ▪ Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics**	**S2, S3**	▪ Problem classes and group tutorial. • Homework assignments as well	▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	covered by the course.		as problems solutions.	
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4, S5**	• 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Solar Energy Conversion:** Photovoltaic, Photo electrochemical, Photothermal, Thermoelectric systems, Solar insulation, World energy demand, Current energy consumption from different sources, Environmental and health effects Sustainable energy, Production and storage.	**8**
2.	**Photovoltaics (PV):** Fundamentals of solar cells, Types of solar cells, Semiconducting materials, Band gap theory, Absorption of photons, Excitons and photoemission of electrons, Band engineering, Solar cell properties and design, p-n junction photodiodes, Depletion region, Electrostatic field across the depletion layer, Electron and holes transports, Device physics, Charge carrier generation, Recombination and other losses, I-V characteristics, Output power, Single junction and triple-junction solar panels, Metal-semiconductor heterojunctions, Semiconducting materials for solar cells.	**8**
3.	**Solar Cell Applications:** PV cell interconnection, module structure and module fabrication, equivalent circuits, Load matching, Efficiency, Fill factor, Optimization for maximum power, Design of stand-alone PV systems, System sizing, Device structures, Device construction, Installation, Measurements; DC to AC conversion, Inverters, On-site storage, Grid connections, Solar cell manufacturing processes, Material resources, Chemistry, Environmental impacts; Low cost manufacturing	**8**

	processes.	
4.	**Optical Engineering:** Optical design, Anti-reflection coatings, Beam splitters, Surface structures for maximum light absorption, Operating temperature versus conversion efficiency, Types of solar energy concentrators, Fresnel lenses and Fresnel reflectors, Operating solar cells at high incident energy for maximum power output.	**10**
5.	**Thin film Solar Cells:** Single crystal, Polycrystalline and amorphous silicon solar cells, Cadmium telluride thin-film solar cells, Conversion efficiency, Current trends in photovoltaic research and applications, Nanotechnology applications, Quantum dots, Solution based processes solar cell production.	**10**
6.	**Photoelectrochemical Cells for Hydrogen Production:** Photoelectrochemical electrolysis, Photoelectrochemical cells for hydrogen production, Solar-to hydrogen efficiency, Hydrogen storage, Hydrogen economy.	**8**
7.	**Solar thermal conversion:** Low, Medium and high temperature collectors, Types of solar energy collectors, Heat storage, Storage media, Steam accumulator, Other storage systems, Heat exchangers and applications of stored energy.	**8**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4thweek**	**25 %**
3.	**Midterm Exam 2**	**8thweek**	**25 %**
4.	**Final Exam**	**12thweek**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Green M. A., ***Solar Cells: Operating Principles, Technology and system Applications,*** Published by the University of New South Wales, ISBN 0 85823 580 3 (1998).
Supportive References	Physics of Solar Energy by C. Julian Chen, John Wiley & Sons Inc, 2011.
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**

Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms. - Labs.
Technology equipment (projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students Second examiner	Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)
Effectiveness of Students assessment	Instructors	Direct (exams, HW, project, ...)
Quality of learning resources	Faculty Students	indirect (surveys)
The extent to which CLOs have been achieved	Instructors Program Leaders	Direct (excel sheet)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

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Course Specification
(Bachelor)

Course Title:	**Fundamentals of Photonics**
Course Code:	**PHY 1440**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General Description:					
This course provides the essential background in photonics necessary to understand modern photonic and optoelectronic phenomena and devices based on classical and quantum properties of radiation. It covers Electromagnetic optics, polarization and crystal optics, guided-wave optics, fiber optics, photons in semiconductors, semiconductors in photon sources and detectors, nonlinear optics, electro-optics, and acousto-optics, quantum theory of light, matter and its interaction, classical and quantum noise, lasers and laser dynamics, and semiconductor optoelectronics and nonlinear optics.					
5. Pre-requirements for this course (if any)**:**					
Electronics, PHY 1324					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Introduce students to basic principles and fundamentals of photonics.**
- **Understand the knowledge of semiconductor lasers and provides a general knowledge of optical devices employing electro-optic, acousto-optic, and nonlinear effects.**
- **Present a solution to a physics problem in a clear and logical written form.**

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the scientific method of inquiry to conclude the concepts of photons optics and atoms.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Describe the scientific method of inquiry to conclude the concepts of laser and laser amplifiers.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Describe the scientific method of inquiry to conclude the concepts photonic in semiconductors.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.4	**Describe the scientific method of inquiry to conclude the concepts of electro-optics, nonlinear optics and acousto-optics.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying waves and optical physics.**	**S1, S2**	▪ 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.**	**S2, S3**	▪ 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.**	**S4, S5**	• 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Photons Optics and Atoms:** Photon, Photon streams, Quantum states of light, Atoms, Molecules, Solids, Interaction of Photons with atoms, thermal light, Luminescence light.	**12**
2.	**Laser Amplifiers and Laser:** Laser amplifier, Amplifier power source, Amplifier nonlinear, Amplifier Noise, Theory of laser oscillation, Pulsed Laser.	**8**

3.	**Photonic in Semiconductors:** Semiconductors, Interactions of photons with electrons and holes, Light-emitting diodes, Semiconductors laser amplifier, Semiconductor injection lasers, Properties of semiconductors photo-detectors, Photon-conductors, Photon-diodes, Noise in photon-detectors.	**12**
4.	**Electro-Optics:** Principles of electro-optics, Electro-optics of anisotropic media, Electro-optics of Liquid crystals, Photorefractive materials.	**8**
5.	**Nonlinear Optics:** Nonlinear optical media, Second-order nonlinear optics, Third-order nonlinear optics, Coupled-wave theory of three-wave mixing, Coupled-wave theory of four-wave mixing, Anisotropic nonlinear media, Dispersive nonlinear, Optical solitons.	**12**
6.	**Acousto-Optics:** Interaction of Light and Sound, Acousto-optic devices, Acousto-optics of anisotropic media.	**8**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
3.	**Midterm Exam 2**	**8th week**	**25 %**
4.	**Final Exam**	**16th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Bahaa E. A.S. and Malvin C.T., ***Fundamentals of Photonics,*** 2nd Edition, Wiley (2007).
Supportive References	
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms,	**- Classrooms.** **- Labs.**

Items	Resources
simulation rooms, etc.)	
Technology equipment (projector, smart board, software)	**- Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students** **Second examiner**	**Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**Instructors**	**Direct (exams, HW, project, …)**
Quality of learning resources	**Faculty** **Students**	**indirect (surveys)**
The extent to which CLOs have been achieved	**Instructors** **Program Leaders**	**Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**Quality Unit-Physics Department**
REFERENCE NO.	**Department council No. 06**
DATE	**26/09/2024**

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Course Specification

(Bachelor)

Course Title	**Laser Physics**
Course Code:	**PHY 1445**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

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A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General Description:					

This course provides a clear, up-to-date, and comprehensive introduction to the physical and principles of laser operation and design. Simple explanations, based throughout on key underlying concepts, lead from the basics of laser action to advanced topics in laser physics. The course is aimed to give students practical skills and certain degree of confidence for working with lasers and/or using laser-based equipment in future.

5. Pre-requirements for this course (if any)**:**

Atomic physics, PHY 1362

6. Co-requisites for this course (if any)**:**

7. Course Main Objective(s):

- **Understand the fundamental of laser physics and provide an overview of the physics of modern optical technology.**
- **Full knowledge of the description to describe the interaction of light with matter.**
- **To understand some applications of lasers and the associated physics.**
- **Deep understanding about laser device design and its performance.**
- **Laser applications in different disciplines such as of military, medical and industrial.**

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the scientific method of inquiry to conclude concepts of ordinary Light and Lasers.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Describe the scientific method of inquiry to conclude concepts of the Laser Action.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Describe the scientific method of inquiry to conclude concepts of laser Oscillator.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**Describe the scientific method of inquiry to conclude concepts of properties of laser radiations.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.5	**Describe the scientific method of inquiry to conclude concepts of Laser System.**	**K1, K2**	• Lectures. • Class discussions. Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying laser physics.**	**S1, S2**	▪ 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.**	**S2, S3**	▪ 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.**	**S4, S5**	▪ 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Ordinary Light and Lasers:** Nature of the Light, Brief history of Lasers, Interaction of radiation with matter, Energy levels, Population density, Boltzmann distribution, Transition life-times, Allowed and forbidden transitions, Stimulated absorption, Spontaneous emission and stimulated	**12**

	emission, Einstein's coefficients, Einstein's relations.	
2.	**Laser Action:** Condition for large stimulated emission, Population inversion, Condition for light amplification, Gain co-efficient, Threshold gain coefficient, Line shape function, Active medium, Metastable states, Pumping schemes: three level and four level.	**12**
3.	**Laser Oscillator:** Optical feedback, Round trip gain, Threshold gain, Critical population inversion, Optical resonator, Condition for steady state oscillations, Cavity resonance frequencies.	**12**
4.	**Properties of Laser Radiations:** Laser Line-width, Laser frequency stabilization, Beam Divergence, Beam coherence, Brightness, Focusing properties of laser radiation, Laser modes, Doppler broadening, Broadening small signal gain, 3 level laser and 4 level rate equations Q-switching.	**12**
5.	**Laser System:** Active medium. Excitation mechanism feedback mechanism. Atom Gas: Helium-Neon laser (He-Ne). Ion gas, Argon ion laser (Ar+). Molecular Gas: Carbon dioxide laser (CO2). Nitrogen laser (N2). Solid state lasers: Ruby laser. Neodymium YAG and Nd glass laser. Diode laser: (semiconductor laser, injection laser) - Liquid Laser: Dye laser.	**12**
6.	**Ordinary Light and Lasers:** Nature of the Light, Brief history of Lasers, Interaction of radiation with matter, Energy levels, Population density, Boltzmann distribution, Transition life-times, Allowed and forbidden transitions, Stimulated absorption, Spontaneous emission and stimulated emission, Einstein's coefficients, Einstein's relations.	**12**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
3.	**Midterm Exam 2**	**8th week**	**25 %**
4.	**Final Exam**	**12thweek**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	-	Silfvast W.T., ***Laser Principles,*** 2nd Edition, Cambridge, ISBN 0-521-83345-0, (2004).
Supportive References	-	Masilamani V. and Azzeer A.M., ***Laser: The Light***

	Extraordinary, Anuradha Agencies (1999).
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**- Classrooms.** **- Labs.**
Technology equipment (projector, smart board, software)	**- Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students** **Second examiner**	**Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**Instructors**	**Direct (exams, HW, project, …)**
Quality of learning resources	**Faculty** **Students**	**indirect (surveys)**
The extent to which CLOs have been achieved	**Instructors** **Program Leaders**	**Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**Quality Unit-Physics Department**
REFERENCE NO.	**Department council No. 06**
DATE	**26/09/2024**

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission
اعتماد
NCAAA
2024
TP-153

Course Specification

(Bachelor)

Course Title	**Atomic and Molecular Spectroscopy**
Course Code:	**PHY 1447**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year4)					
4. Course General Description:					
The main aim of this course is to introduce the student to spectroscopy in a clear manner which avoids, as far as possible, the mathematical aspects of the subject. After explaining the theory behind spectroscopy, the course then goes on to look at the different techniques, such as rotational, vibrational and electronic spectroscopy. It encompasses both high resolution (structural) and low resolution (analytical) spectroscopy, demonstrating their close interrelationship.					
5. Pre-requirements for this course (if any)**:**					
Atomic Physics, PHY 1362					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Give the basic principles and applications of atomic and molecular spectroscopy.**
- **Familiarize students with fundamental concepts of atomic structure.**
- **Acquaint with the different types of molecular spectra.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom		

No	Mode of Instruction	Contact Hours	Percentage
	• E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the scientific method of inquiry to conclude concepts atomic structure.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Describe the scientific method of inquiry to conclude concepts of Structure of molecules.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Outline the scientific method of inquiry to conclude concepts of emission and absorption of electromagnetic radiation.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**State the scientific method of inquiry to conclude concepts of Spectrum.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.5	**Describe the scientific method of inquiry to conclude concepts of combined techniques.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.6	**Recognize the scientific method of inquiry to conclude concepts of the Spectroscopy.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying Atomic and Molecular Spectroscopy**	**S1, S2**	▪ 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.**	**S2, S3**	▪ 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.**	**S4, S5**	• 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Atomic Structure:** Historical notes, Models of atoms, spectral line series, orbitals electron shells, energy term of atoms.	8
2.	**Structure of molecules:** Quantum states of molecules, molecular orbital's, vibration and rotation energetic levels.	8
3.	**Emission and absorption of electromagnetic radiation:** Quantum transitions, Spontaneous and simulated emission, absorption of radiation, spectral line, Röntgen and characteristic radiation.	8
4.	**Spectrum:** Splitting of energy levels, Zeeman and Stark effect Separation methods: classification of separation methods, principles of chromatography, liquid and gas chromatography.	8

5.	**Combined techniques:** Mass spectrometer, Fourier transformation in mass spectrometry.	8
6.	**Spectroscopy:** Classification of methods, basic principles of spectroscopy. Emission, absorption and diffraction spectroscopic methods, basic blocks of a spectrometric line, Lambert-Beer Law.	8
7.	**Atomic absorption spectroscopy:** Basic scheme, sources of radiation, atomizer, monochromator, applications of AAS.	6
8.	**Atomic emission spectroscopy:** Basic scheme, sources of radiation, inductively coupled plasma, fluorescence spectroscopy, fluorescence quenching.	6
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
3.	**Midterm Exam 2**	**8th week**	**25 %**
4.	**Final Exam**	**12th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- Michael Holl J., ***Basic Atomic and Molecular Spectroscopy,*** Royal Society of Chemistry (2002).
Supportive References	- Svanberg S., ***Atomic and Molecular Spectroscopy: Basic Aspects and Practical Applications,*** 4th Edition, Springer (2001).
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms. - Labs.

Items	Resources
Technology equipment (projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students** **Second examiner**	**Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**Instructors**	**Direct (exams, HW, project, …)**
Quality of learning resources	**Faculty** **Students**	**indirect (surveys)**
The extent to which CLOs have been achieved	**Instructors** **Program Leaders**	**Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission
اعتماد
NCAAA
2024
TP-153

Course Specification

(Bachelor)

Course Title	**Introduction to Plasma Physics**
Course Code:	**PHY 1449**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General Description:					
This course offers both a simple and intuitive discussion of the basic concepts of the plasma physics and controlled fusion and an insight into the challenging problems of current research. In a wholly lucid manner the course covers single-particle motions, fluid equations for plasmas, wave motions, diffusion and resistivity, Landau damping, plasma instabilities and nonlinear problems. For students, this outstanding text offers a painless introduction to this important field.					
5. Pre-requirements for this course (if any)**:**					
Electromagnetic Fields, PHY 1321					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Describe, and perform simple calculations involving, the motion of charged particle in electric and magnetic field and how deduce the complete set equations of plasma when it is considered as fluid.**
- **Strengthen an understanding of the concepts and principles through a broad range of the interesting applications to the real world.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		

No	Mode of Instruction	Contact Hours	Percentage
4	Distance learning		

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Recognize the scientific method of inquiry to conclude concepts of ordinary Light and Lasers.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Describe the scientific method of inquiry to conclude concepts of the Laser Action.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Describe the scientific method of inquiry to conclude concepts of laser Oscillator.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**Describe the scientific method of inquiry to conclude concepts of properties of laser radiations.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.5	**Describe the scientific method of inquiry to conclude concepts of Laser System.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.1	**Explain and summarize the basic knowledge gained from studying waves and optical physics.**	**S1, S2**	• 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.**	**S2, S3**	• 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.**	**S4, S5**	• 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Introduction:** Occurrence of Plasmas in Nature, Definition of Plasma, Concept of temperature, Debye Shielding, Plasma parameter, Criteria for plasmas, Applications of plasma physics.	**8**
2.	**Single-Particle Motions:** Introduction, Uniform E and B fields, Nonuniform B field, Nonuniform E field, Time- Varying E Field, Time-varying B field, Summary of guiding center drifts, Adiabatic invariants.	**8**
3.	**Plasmas as Fluids:** Introduction, Relation of plasma physics to ordinary electromagnetic, Fluid equation of motion, Fluid Drilts perpendicular to B, Fluid Drilts parallel to B, Plasma Approximation.	**8**
4.	**Waves in Plasmas:** Representation of waves, Group velocity, Plasma oscillations, Electron plasma Waves, Sound waves, Ion waves, Validity of the plasma approximation, Comparison of ion and electron waves, Electrostatic electron oscillations perpendicular to B, Electrostatic ion	**12**

	waves perpendicular to B, Lower Hybrid frequency, Electromagnetic waves with Bo = 0, Experimental applications, Electromagnetic waves perpendicular to Bo, Cutoffs and resonances, Electromagnetic waves parallel to Bo, Experimental consequences, Hydromagnetic waves, Magnetosonic waves, Summary of elementary plasma waves, CMA Diagram.	
5.	**Diffusion and Resistivity:** Diffusion and mobility in weakly ionized gases, Decay of a plasma by diffusion, Steady state solutions, Recombination, Diffusion across a magnetic Field, Collisions in fully ionized plasmas, Single-fluid MHD equations, Diffusion in fully ionized plasmas, Solutions of the diffusion equation, Bohm diffusion and neoclassical diffusion.	**8**
6.	**Equilibrium and Stability:** Introduction, Hydromagnetic equilibrium, concept of ß, Diffusion of magnetic Field into a plasma classification of instabilities, Two-Stream instability The "Gravitational" instability, Resistive drift Waves The Weibel instability.	**8**
7.	**Kinetic Theory:** Meaning of f(v), Equations of kinetic Theory, Derivation of the fluid Equations, Plasma oscillations and Landau damping, Meaning of Landau damping, A physical derivation of Landau damping, BGK and Van Kampen modes, Experimental verification, Ion Landau damping, Kinetic effects in a magnetic field.	**8**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
3.	**Midterm Exam 2**	**8th week**	**25 %**
5.	**Final Exam**	**12thweek**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Chen F.F., ***Introduction to Plasma Physics and Controlled Fusion,*** Volume 1, Springer (2006).
Supportive References	
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**

Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**- Classrooms.** **-Labs.**
Technology equipment (projector, smart board, software)	**- Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students** **Second examiner**	**Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**Instructors**	**Direct (exams, HW, project, …)**
Quality of learning resources	**Faculty** **Students**	**indirect (surveys)**
The extent to which CLOs have been achieved	**Instructors** **Program Leaders**	**Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission
اعتماد
NCAAA
2024
TP-153

Course Specification
(Bachelor)

Course Title	**Introduction to Radiation Physics**
Course Code:	**PHY 1469**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year4)					
4. Course General Description:					
This course offers students a comprehensive coverage of the major concepts that underlie the origins and transport of ionizing radiation in matter. Understanding atomic structure and the physical mechanisms of radiation interactions is the foundation on which much of the current practice of radiological health protection is based. The course covers the detection and measurement of radiation and the statistical interpretation of the data. The procedures that are used to protect man and the environment from the potential harmful effects of radiation are thoroughly described. Basic principles are illustrated with an abundance of worked examples that exemplify practical applications.					
5. Pre-requirements for this course (if any)**:**					
Nuclear Physics, PHY 1464					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Differentiate between an ionized and non-ionized radiation.**
- **Deep understand the principals of interaction radiation with matter.**
- **Full knowledge of the different units of exposure, dose absorbed dose.**
- **Understand some applications of radiation in medicine.**
- **Understanding biological effects of Radiation.**

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Define and recall the basic knowledge of Radiation Physic.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Recognize the interaction of ionizing radiation with matter.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Recall the different radiation detection methods.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**State the concepts of the biological Effects of Radiation.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize**	**S1, S2**	▪ Lectures.	▪ Exams.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	the basic knowledge gained from studying waves and optical physics.		▪ Class discussions. ▪ Tutorials.	▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	▪ 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.**	**S4, S5**	• 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Radioactive Decay:** Activity, Exponential decay, Specific activity, Serial radioactive decay, Natural radioactivity, Radon and radon daughters.	**8**
2.	**Interaction of Heavy Charged Particles with Matter:** Energy-loss mechanism, Maximum energy transfer in a single collision, Single-collision energy-loss spectra, Stopping power, Semiclassical calculation of stopping power, Bethe formula for stopping power, Mean excitation energies, Stopping power of water for protons, Range, Slowing-down time.	**8**
3.	**Interaction of Electrons with Matter:** Energy-loss mechanism, Collisional stopping power, Radiative stopping power, Radiation yield, Range, Slowing-down time, Examples of electron tracks in water.	**8**
4.	**Interaction of Photons with Matter:** Interaction mechanisms, Photoelectric effect, Energy-momentum requirements for photon absorption by an electron, Compton effect, Pair production, Photonuclear reactions, Attenuation coefficients, Energy-transfer and energy-	**80**

	absorption coefficients, Calculation of energy absorption and energy transfer.	
5.	**Neutrons, Fission and Criticality:** Neutron sources, Classification of neutrons, Interactions with matter, Elastic scattering, Neutron-proton scattering energy-loss spectrum, Reactions, Energetics of threshold reactions, Neutron activation, Fission, Criticality.	**8**
6.	**Methods of Radiation Detection:** Ionization in gases, Ionization in semiconductors, Scintillation, Photographic film, Thermo-luminescence, Other methods, Neutron detection.	**8**
7.	**Radiation Dosimetry:** Quantities and units, Measurement of exposure, Measurement of absorbed dose, Measurement of X- and gamma-ray dose, Dose measurements for charged-particle beams, Dose calculations, Other dosimetric concepts and quantities.	**8**
8.	**Biological Effects of Radiation:** Biological effects, Radiation biology, Dose-response relationship, Factors affecting dose response.	**4**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
3.	**Midterm Exam 2**	**8th week**	**25 %**
4.	**Final Exam**	**12th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Turner J.E., ***Atoms, Radiation, and Radiation Protection,*** Wiely-VCH Verlag GmbH & Co. KGaA (2007).
Supportive References	Attix F.H., ***Introduction to Radiological Physics and Radiation Dosimetry,*** Wiely-VCH Verlag GmbH & Co. KGaA(1986).
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- Classrooms. - Labs.
Technology equipment (projector, smart board, software)	- Classroom equipped with a whiteboard and a projector.
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students Second examiner	Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)
Effectiveness of Students assessment	Instructors	Direct (exams, HW, project, …)
Quality of learning resources	Faculty Students	indirect (surveys)
The extent to which CLOs have been achieved	Instructors Program Leaders	Direct (excel sheet)
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

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Education & Training Evaluation Commission
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2024
TP-153

Course Specification

(Bachelor)

Course Title:	**Selected Topics in Applied Physics (1)**
Course Code:	**PHY 1471**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General 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.					
5. Pre-requirements for this course (if any)**:**					
Atomic Physics, PHY 1362					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					
Selected Topics in Physics (STP) will highlight a specific topic in physics, which will be selected by the Department council. The STP 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 inter-disciplines. A decision of the selected areas planned for future issues will be decided in the Department of Physics by the Department Council.					

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	Apply of the fundamental principles to particular areas.	K1, K2	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	Select of subjects which students' study in greater depth, learning of current developments at the frontiers of the subject.	K1, K2	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	Outline knowledge of the principles of operations to particular areas.	K1, K2	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	Knowledge and skills in advanced mathematics and its application in physics.	K1, K2	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	Skills			
2.1	Explain and summarize the basic knowledge gained from studying the course.	S1, S2	▪ 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.	S2, S3	▪ Problem classes and group tutorial. ▪ Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	Communicate in a clear and concise manner	S4, S5	• Lectures. • Class discussions.	▪ Exams. ▪ Participation

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	orally, and 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.	and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility.**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
	Depending of the selected subject	
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
4.	**Midterm Exam 2**	**8th week**	**25 %**
5.	**Final Exam**	**12th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	
Supportive References	
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default**

	.aspx
Other Learning Materials	Laboratory Manual supplied by the Department of Physics. Laboratory Manual is available at the website of the Department of Physics.

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	- **Classrooms.** - **Labs.**
Technology equipment (projector, smart board, software)	- **Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- **Students** - **Second examiner**	- **Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	- **Instructors**	- **Direct (exams, HW, project, …)**
Quality of learning resources	- **Faculty** - **Students**	- **Indirect (surveys)**
The extent to which CLOs have been achieved	- **Instructors** - **Program Leaders**	- **Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

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Course Specification

(Bachelor)

Course Title:	**Selected Topics in Applied Physics (2)**
Course Code:	**PHY 1472**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General 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.					
5. Pre-requirements for this course (if any)**:**					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					
Selected Topics in Physics (STP) will highlight a specific topic in physics, which will be selected by the Department council. The STP 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 inter-disciplines. A decision of the selected areas planned for future issues will be decided in the Department of Physics by the Department Council.					

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Apply of the fundamental principles to particular areas.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Select of subjects which students' study in greater depth, learning of current developments at the frontiers of the subject.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Outline knowledge of the principles of operations to particular areas.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.4	**Knowledge and skills in advanced mathematics and its application in physics.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying the course.**	**S1, S2**	▪ 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.**	**S2, S3**	▪ Problem classes and group tutorial. ▪ Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4, S5**	• 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, autonomy, and responsibility.**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
	Depending of the selected subject	
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4thweek**	**25 %**
3.	**Midterm Exam 2**	**8thweek**	**25 %**
4.	**Final Exam**	**12thweek**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	
Supportive References	
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	Laboratory Manual supplied by the Department of Physics. Laboratory Manual is available at the website of the Department of Physics.

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**- Classrooms.** **- Labs.**
Technology equipment (projector, smart board, software)	**- Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**- Students** **- Second examiner**	**- Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**- Instructors**	**- Direct (exams, HW, project, …)**
Quality of learning resources	**- Faculty** **- Students**	**- Indirect (surveys)**
The extent to which CLOs have	**- Instructors**	**- Direct (excel sheet)**

Assessment Areas/Issues	Assessor	Assessment Methods
been achieved	- Program Leaders	
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024

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Course Specification

(Bachelor)

Course Title	**Introduction to Nanophysics**
Course Code:	**PHY 1473**
Program:	**Bachelor of Science in Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	1
Last Revision Date:	***26/09/2024***

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours: (4)					
2. Course type					
A.	☐ University	☐ College	☒ Department	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: (Level 11/ Year 4)					
4. Course General Description:					
Introduction to nanotechnology provides a self-contained introduction to the physical concepts, techniques and applications of nanoscale systems by covering its entire spectrum from the latest examples right up to single-electron and molecular electronics. This course discusses the interdisciplinary nature of nanotechnology and how the different basic sciences merge to create the field and it provides a background of the understanding, motivation, implementation, impact, future, and implications of nanotechnology. The course will also discuss specific applications of nanotechnology in electronic devices, and energy production.					
5. Pre-requirements for this course (if any)**:**					
Atomic Physics, PHY 1362					
6. Co-requisites for this course (if any)**:**					
7. Course Main Objective(s):					

- **Initiate students with new concepts in nanoscience.**
- **Provide the student with a clear and logical presentation of the basic concepts of nanophysics.**
- **Describe, and perform simple calculations involving, the quantization in different dimensions (3D, 2D, 1D and 0D).**
- **Strengthen an understanding of the concepts and principles through a broad range of the interesting applications in nanotechnology.**

2. Teaching mode (mark all that apply)

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

3. Contact Hours (based on the academic semester)

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

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Describe and learn basic theoretical concepts of nanophysics allowing working in research and development in nanotechnology.**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Participation. ▪ Discussions.
1.2	**Outline the rapidly developing field of nanoengineered materials with special focus on their electronic properties**	**K1, K2**	• Lectures. • Tutorials. • Class discussions.	▪ Exams. ▪ Homework. ▪ Quizzes.
1.3	**Recognize the studies of various phenomena in small-size devices.**	**K1, K2**	• Lectures. • Class discussions. Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.4	**State aspects of the electronic properties of materials, as well as fabrication processes.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Skills**			
2.1	**Explain and summarize the basic knowledge gained from studying waves and optical physics.**	**S1, S2**	▪ 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.**	**S2, S3**	▪ 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.**	**S4, S5**	• 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, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Generalities on Nanotechnology:** Definitions, Comparison between units, History, Richard Feynman, Norio Taniguchi, Fundamental concepts, Bottom-up and top-down, Importance of nanosystems, Quantification, Specific surface area.	**10**

2.	**Principle Synthesis Techniques of Nanosystems:** Generalities on germination mechanism, Activation energy of nucleation, Critical germ dimension, Stability of the germ, Chemical techniques, Free nanoparticles, Metallic salt reduction, Sol-gel, Solvo-thermal, Physical techniques, Thermal evaporation, Milling, Pulse laser deposition (PLD), Electrical discharge, Sputtering, Molecular beam epitaxy (MBE), Chemical vapour deposition (CVD).	**12**
3.	**Quantification:** Free electron and electrons in solid, Gaz of electrons, Description of free electrons in solid, Concept of effective mass, Quantification condition, Born Van Kerman (BVK) conditions, Energy levels of free electron in solid, State densities in different structures 3D, 2D, 1D and 0D, Applications of systems 0D and 1D.	**10**
4.	**Porosity and Texture of Materials:** Divided state, Specific surface area, Generalities on textural characterizations of porous solids, Gurwitsch equation, Porosity.	**10**
5.	**Characterization techniques:** Scanning electron microscopy (SEM), Transmission electron microscopy, Adsorption-desorption characterization methods, Photoluminescence, Electronic characterization, Magnetic characterizations.	**10**
6.	**Some applications:** Quantum effects in opto-electronic devices, Photo catalytic processes, Gaz sensors.	**8**
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc.....)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**4th week**	**25 %**
3.	**Midterm Exam 2**	**8th week**	**25 %**
4.	**Final Exam**	**12th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- Wolf E. L., ***Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience,*** 2nd Edition; Wiley (2006). - Binns C., ***Introduction to Nanoscience and Nanotechnology***, Wiley (2010). Cao G. and Wang Y., ***Nanostructures and Nanomaterials:***

	Synthesis, Properties and Application, 2nd Edition, World Scientific (2011).
Supportive References	
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**- Classrooms.** **- Labs.**
Technology equipment (projector, smart board, software)	**- Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	**Students** **Second examiner**	**Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	**Instructors**	**Direct (exams, HW, project, …)**
Quality of learning resources	**Faculty** **Students**	**indirect (surveys)**
The extent to which CLOs have been achieved	**Instructors** **Program Leaders**	**Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	**Quality Unit-Physics Department**
REFERENCE NO.	**Department council No. 06**
DATE	**26/09/2024**

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Course Specification

(Bachelor)

Course Title:	Introduction to Operations research
Course Code:	MAT 1253
Program:	Bachelor of Science in Physics
Department:	Mathematics and Statistics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	2024 – V1
Last Revision Date:	08/10/2024

Table of Contents

A. General information about the course:

1. Course Identification

1. Credit hours:					
4 (3 Lectures, 0 Lab, 2 Tutorial)					
2. Course type					
A.	☐ University	☐ College	☒ Program	☐ Track	☐ Others
B.	☐ Required		☒ Elective		
3. Level/year at which this course is offered: Level 11-12 / Year 4					
4. Course general Description:					
This course covers key operations research techniques, focusing on linear programming, the Simplex Method, duality, and sensitivity analysis. Students will explore special models like transportation and assignment problems, as well as integer linear programming applications, including the Traveling Salesman Problem. Practical problem-solving is emphasized through the use of TORA software.					
5. Pre-requirements for this course (if any):					
MAT 1222					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
The Introduction to Operations Research course plays a vital role in the BSc degree program in Applied Mathematics by equipping students with essential optimization techniques and decision-making tools. It enhances their analytical skills and prepares them for practical applications in fields like economics, engineering, and logistics.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	**60**	**100%**
2	E-learning	**0**	**0%**
3	Hybrid • Traditional classroom • E-learning	**0**	**0%**
4	Distance learning	**0**	**0%**

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	36
2.	**Laboratory/Studio**	0
3.	**Field**	0

4.	**Tutorial**	24
5.	**Others (specify)**	0
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	Identify a Linear Programming Problem and its formulation.	K1	3lecture hours\week 2tutorial hours\week Self-study	Regular Exams Assignments Short Quizzes
1.2	Summarize techniques of operations research including Linear Programming, Assignment Problem. Integer programming, simplex, duality and sensitive analysis.	K1, K2	3lecture hours\week 2tutorial hours\week Self-study	Regular Exams Assignments Short Quizzes
2.0	**Skills**			
2.1	Solve proposed real-life problems by applying the methodology and tools of Operations Research including Linear Programming, Assignment Problem. Integer programming, simplex, duality and sensitive analysis.	S1, S2	Self-study Real-life problems	Participations Short Quizzes
2.2	Model in mathematical language understandable operational research problems from the verbal description of the real system.	S4	Self-study Real-life problems	Participations Short Quizzes
2.3	Use of TORA software to solve and online solver to solve some to solve the proposed models..	S5	Self-study Real-life problems	Participations Short Quizzes
2.4	Employ clearly, the best strategy Solve linear programming problems using appropriate techniques and	S3	Self-study Real-life problems	Participations Short Quizzes

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
	optimization solvers.			
3.0	Values, autonomy, and responsibility			
3.1	work individually.	V1, V3	Class discussion	Participation
3.2	Relate well to others and maintain good relationships;	V1, V2	Class discussion Team work	Homework and Mini-projects

C. Course Content

No	List of Topics	Contact Hours
1.	**Introduction to Linear programming:** Overview, Linear programming formulations, Graphical Linear Programming Solution, Graphical Sensitivity analysis.	**8**
2.	**The Simplex Method:** Standard Linear Programming, Determination of Basic Feasible Solutions; The Simplex Algorithm.	**8**
3.	**Special Cases of the Simplex:** Degeneracy, Alternative optimum, Unbounded solution, Infeasibility.	**6**
4.	**Duality and Sensitivity Analysis:** Formulation of the Dual Problem, Relationship between Optimal Primal and Optimal Dual Solutions, Economic interpretation of Duality, Dual Simplex and Sensitivity Analysis.	**10**
5.	**Special linear programming models:** The transportation model, The assignment model.	**8**
6.	**Introduction to Integer Linear Programming:** Illustrative applications, Branch and Bound algorithm, Application to the Traveling Salesman Problem.	**10**
7.	**Tora Software:** Use of TORA software to solve exercises and problems from all course chapters.	**10**
Total		60

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	HomeWorks, Quizzes, Mini-projects	During the term	10%
2.	First Midterm	Week 4-5	25%
3.	Second Midterm	Week 7-8	25%
4.	Final Exam	Week 13	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	***Operations Research: An Introduction***, H. Taha, Prentice Hall, 8th Edition, 2006. **(Main Reference)**
Supportive References	***Introduction to Operations Research***, F. Hillier and G. Lieberman, 7th Edition, McGraw Hill, 2001
Electronic Materials	
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	• **Classrooms:** Equipped with whiteboards, projectors, and Smart Boards for interactive lessons and group discussions. • **Laboratories:** Feature computers with internet access, enabling hands-on activities and exploration of Linear programing methods.
Technology equipment (projector, smart board, software)	• **Data Show Projectors:** For clear presentations in classrooms and labs. • **Smart Boards:** To enhance interactivity during lessons. • **Mathematical Software:** Essential linear programing
Other equipment (depending on the nature of the specialty)	• **Computers:** For mini-project and homework and practical applications in laboratories. • **Advanced Calculators:** For computations and problem-solving and supporting the study of discrete optimization. • **Whiteboards and Markers:** To facilitate brainstorming and collaboration.

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Student and teaching staff	Surveys and Questionnaires
Effectiveness of Students assessment	Course Coordinator	Peer Reviews

Assessment Areas/Issues	Assessor	Assessment Methods
Quality of learning resources	Students and teaching staff	Classroom Observations
The extent to which CLOs have been achieved	Student Representatives	Student Performance Evaluations (exams, projects) CLOs Excel sheet.
Other	**None**	

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

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
REFERENCE NO.	8/1446
DATE	05/04/1446 (08/10/2024)