M. Sc. Handbook

Physics

Message from Department's HOD

As the Head of the Department of Physics, I would like to welcome you to your choice of the Master of Physics program. The department prides itself on providing an excellent, supportive teaching and teaching environment fully integrated with our research: in your lectures, your laboratories and project work, where you will have the opportunity to interact with the world's leading researchers and work at the forefront of a wide range of fields of physics, who are tackling some of the biggest contemporary challenges in science and technology.

The department is aware of the diversity among all students and their physics programs, and that diversity improves the quality of our work by allowing students to bring in a range of skills and perspectives aimed at enhancing their collective achievement. We therefore expect that all students and faculty will work together productively and professionally in an atmosphere of mutual respect. And when there is any note, the faculty members in the department are more than willing to interact with you, so do not hesitate to talk to them and they will do their best to help.

I hope you enjoy your time with us in the Physics Department and I wish you success in your current and future studies.

best wishes

Physics H.O.D

Introduction

The changes and developments that the education sector in the Kingdom of Saudi Arabia is currently witnessing in response to global developments such as the prevalence of quality systems, academic accreditation, competitiveness, scientific and technical progress, and changing labor market requirements based on excellence and skill uniqueness among graduates made the creation or development of academic programs a continuous matter in order to be able to Keeping pace with providing the scientific value and the qualitative addition that the program adds to the community, the labor market and the surrounding environment, This requires the availability of a number of elements when creating or developing programs, such as the study plan that conforms to national and international standards, the availability of qualified teaching staff with the necessary specializations, the study of the labor market, and the provision of various educational and learning resources that contribute significantly to building an academic program that has the ability to achieve the desired goals.

Like any academic program that aspires to improve and know its impact on the educational process, a clear strategy for self-assessment must be developed through quality standards for all program elements, from teaching, exams, study plan, course descriptions, educational management, etc., as a comprehensive and continuous evaluation that aims to use feedback for development and improvement. Those in charge of the program must have a clear vision and a future development strategy that deals with variables and events and interacts with them for change and constructive modification to serve the focus of the academic process and improve its outcomes.

In order to get acquainted with the Master's program in Physics, we will give an introduction to the college, which will witness the teaching of the program in its flanks. Approval was issued to establish a College of Science in Zulfi on Sha'ban 5, 1426 AH. The study began in the College of Science in the academic year 1427/1428 AH, and the college contains departments (Mathematics, Physics (Computer Science, Biology, Chemistry) The college has obtained academic accreditation from the German ASIIN from 2015 to 2020. The college has more than 623 male students, 355 female students and 100 faculty members. It is equipped with the latest equipment in halls, smart boards, and offices at the latest level. It also has a library stocked with specialized books, in addition to a strong internet network that serves students and faculty members, a sports activities unit, specialized science clubs for different departments, a mosque and a restaurant.

Upon successful completion of the program, the applicant will be awarded a Master of Science in Physics. The program has two tracks: Radiation and Environmental Protection and Materials Science and Applications. The program aims to:

• Preparing distinguished national cadres, scientifically and in research, to contribute to the service and development of the local and regional community.

• Training qualified researchers in the field of physics and its applications.

• Work to localize the formation of postgraduate students and train them to conduct research in vital areas.

• Preparing specialists who can provide services to hospitals (medical imaging, x-rays, ..). Or in the field of nuclear energy, renewable energy, or modern materials and their uses (solar energy, medicine, ...).

• Providing local educational opportunities for holders of higher degrees to continue their studies in an applied field in the Physics Department, which has many modern equipment and human resources.

• Consolidating the culture of applied scientific research and scientific publishing in a continuous and growing manner in scientific journals classified globally.

Program admission requirements

• The applicant should be a Saudi, or an official scholarship holder for postgraduate studies if he is a non-Saudi.

• The applicant must have a university degree from a Saudi university or from another recognized university.

• The applicant must have a Bachelor of Science in Physics.

• To be of good conduct and behavior and medically fit.

• To submit two scientific recommendations from professors who have taught him previously.

• The employer's approval of the study if he is an employee.

• The student has obtained a grade of "very good" at least at the undergraduate level.

• Obtaining a minimum score of 70 in the general aptitude test for university students.

• The applicant must have obtained an IELTS score of greater than 3.5 or its equivalent in the tests

Other approved.

• University degree holders with the affiliation system are not accepted.

The relative weights of the acceptance criteria

The differential ranking of applicants for the program is based on the following criteria:

1- The applicant’s cumulative grade point average out of 5 (M symbol) and the weight is 50 degrees, and it is calculated as follows:

If the cumulative average is 2.5, the candidate will get 0 points. If the cumulative average is 5, the candidate gets 50 points. The grade increases linearly with the GPA, i.e., a=20x(M-2.5)

2- The score obtained in the General Aptitude Test for Undergraduates (T symbol), and the weight is 30 degrees, and it is calculated as follows:

- The score obtained in this criterion is equal to one third of the score obtained in the General Aptitude Test for undergraduates, with a maximum score of 30, i.e., b = min (T/3,30)

The score obtained in the English language test (code E) The STEP test is approved and the results obtained in another test (TOEFL, IELTSTS) are transferred and the weight is 20 and calculated as follows:

If the score obtained in the STEP test is 50, the candidate gets 10 points and gets 20 points if the score obtained in the STEP test is equal to 100, i.e., c=0.2xE

The total score (score) is calculated in the following way: Score = a + b +c

The expected need for the labor market for graduates of this department

Teaching at the university, as the number of Saudi faculty members in the department requires strengthening it.

• There is a cooperation agreement in the process of concluding with King Abdullah City for Atomic and Renewable Energy.

• Work in hospitals and health clinics in the departments of medical imaging, radiology, and magnetic resonance.

• Work in studies and consulting offices in the field of energy, materials engineering, and the environment.

• According to the Ministry of Civil Service, there are some jobs, for example, researchers and standards, metrology, and calibration specialists, and also in the jobs of heads of meteorological and environmental monitoring sub-stations (rank 8).

The expected outputs that graduates will acquire after completing this program

• The ability to deal with different devices that deal with many physical phenomena required in the field of work.

• Good handling of mathematical models, which allow good handling of meteorological models, for example.

• The graduate acquires skills in dealing with theories of physics, which qualifies him to work skillfully in the field of teaching and research

Learning outcomes (NCAAA)

A- Knowledge

1 Recognize the concept of physics at an advanced level in their fields of physical study to solve complex problems.

2 Basic knowledge and interdisciplinary approach to physics.

3 Master the basic knowledge of physics.

4 Identify key factors and apply appropriate principles and assumptions in formulating physics problems.

b- Skills:

1 Conducting experiments, obtaining data, analyzing data, and drawing conclusions and conclusions.

2 Explanation to a general audience, whether other experts in the field or to people outside the field, the concepts, and results of physics.

3 The ability to use analytical or computational methods to solve physics problems

4 Apply theories and concepts of physical relations related to global research in local and international contexts.

C- Competences:

1 Work effectively in groups as well as individually

2 Use the appropriate tools and media literacy required to acquire, evaluate and analyze data and information from a variety of sources

Possess time management skills.

3 Apply appropriate scientific programming skills

4 Possess time management skills.

5 Pay attention to professional and ethical responsibilities.

Program Curriculum Plan

First Level									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		
611	PHYS	Computational Physics	Mandatory	3			3		
612	PHYS	Advanced Quantum Mechanics	Mandatory	3			3		
613	PHYS	Electrodynamics	Mandatory	3			3		
Total				9			9		

Second Level (Radiation Track)									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		
621	PHYS	Advanced Nuclear Physics	Mandatory	3			3	PHYS 612 PHYS 613	Advanced Quantum Mechanics Electrodynamics

622	PHYS	Radiation Physics and Dosimeter	Mandatory	2	2		3	PHYS 612 PHYS 613	Advanced Quantum Mechanics Electrodynamics
623	PHYS	Statistical Physics	Mandatory	2			2	PHYS 612 PHYS 613	Advanced Quantum Mechanics Electrodynamics
Total				7	**2**		8		

Second Level (Materials Track)									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		
62**4**	PHYS	Physics and Technology of Semiconductors	Mandatory	3			3	PHYS 612 PHYS 613	Advanced Quantum Mechanics Electrodynamics
62**5**	PHYS	Characterization of Advanced Materials	Mandatory	2	2		3	PHYS 612 PHYS 613	Advanced Quantum Mechanics Electrodynamics
623	PHYS	Statistical Physics	Mandatory	2			2	PHYS 612 PHYS 613	Advanced Quantum Mechanics Electrodynamics
Total				7	**2**		8		

Third Level									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		
630	PHYS	Research Methodology	Mandatory	**2**			**2**		
63x1	PHYS	Elective course	Mandatory	3			3		
63x2	PHYS	Elective course	إجباري	3			3		
Total				**8**			**8**		

Fourth Level									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		
640	PHYS	Dissertation	Academic	6			6	PHYS 630	Research Methodology
Total				6			6		

Elective Courses (Radiation Track)									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		

631	PHYS	Application of Ionizing Radiation Physics	Academic	3			3	PHYS 621 PHYS 622	Advanced Nuclear Physics Radiation Physics and Dosimeter
632	PHYS	Radiation Detection and Measurements	Academic	3			3	PHYS 621 PHYS 622	Advanced Nuclear Physics Radiation Physics and Dosimeter
633	PHYS	Detector Instrumentation	Academic	3			3	PHYS 621 PHYS 622	Advanced Nuclear Physics Radiation Physics and Dosimeter
634	PHYS	Radiation Protection	Academic	3			3	PHYS 621 PHYS 622	Advanced Nuclear Physics Radiation Physics and Dosimeter
Total				6			6		

Elective Courses (Material Track)									
No.	Code	Name	Type	Units' distribution				Pre-request code-No	Pre-request Name
				Lecture	Lab	Exercise	Credit		

635	PHYS	Heat Transfer in Microelectronic Devices	Academic	3			3	PHYS 611	Computational Physics
636	PHYS	Solar Cells	Academic	3			3	PHYS 624	Physics and Technology of Semiconductors
637	PHYS	Non-crystalline materials	Academic	3			3	PHYS 625	Characterization of Advanced Materials
638	PHYS	Nanostructures engineering	Academic	3			3	PHYS 624	Physics and Technology of Semiconductors
639	PHYS	Optical Properties of nanostructures	Academic	3			3	PHYS 625	Characterization of Advanced Materials
Total				6			6		

Staff

No.	Name	Major	Rank
1	Thamer S. Alharbi	Nuclear Physics	Prof.
2	Hafedh Belmabrouk	Fluid dynamics, thermal conduction	Prof.
3	Yasser B. Saddeek	Material Science	Prof.
4	Hassan S. Hanafy	Atomic Physic	Associated Prof.
5	Ibrahim S. Mahmoud	Theoretical Physics	Associated Prof.
6	Mahmoud M. Ahmed	Laser Physics	Assistant Prof.
7	Mohed Shakir Khan	Nuclear Physics	Assistant Prof.
8	Mona H. BenHenda	Polymers	Assistant Prof.
9	Elham Aldufeery	Theoretical Physics	Assistant Prof.

Laboratories

- Material Science Lab.
- Nuclear Lab.
- Scanning Electron Microscope (SEM) Lab.

Assessment Methods

Proportion of Total Assessment	Week Due	Assessment task (e.g. essay, test, group project, examination, presentation, etc.)
20%	9	Midterm
20%	All semester	Assignments
20%	All semester	participation, presentation, attendance etc.
40%	At the end	Final exam

Program Specifications

Phys611: Computational Physics

Course Objectives and Learning Outcomes

1. Course Description
Introduce the basic concepts of numerical analysis and computation using Matlab Programming using Matlab Numerical Solution of Ordinary Differential equations and Partial Differential equations Applications to many physical problems
2. Course Main Objective
Introduce the basic concepts of numerical analysis and computation using Matlab Programming using Matlab. Numerical Solution of Ordinary Differential equations and Partial Differential equations Applications to many physical problems

Course Learning Outcomes

CLOs		Aligned-PLOs
1	**Knowledge:**	
1.1	Introduce the basic concepts of numerical analysis and computation using Matlab	
1.2		
1.3		
1...		
2	**Skills :**	
2.1		
2.2	Applications to many physical problems	
2.3		
2...		
3	**Competence:**	
3.1		
3.2	Programming using Matlab	
3.3		
3...		

Course Content

No	List of Topics	Contact Hours
1	Introduction to Matlab, Complex numbers, Elementary math functions	6

2	Vectors, main operations on vectors, vector functions, Vectors, main operations on vectors, vector functions,	6
3	Matrices, matrix functions, matrix operations, inverse matrix, Linear equations, Eigen values, Eigen vectors, Application to quantum mechanics, Conditional statements, loops (for loop, while loop),	6
4	Functions and subroutines, Input and output arguments, Graphs (2D and 3D plots), polar plots, applications (wave functions, radiation pattern, distribution density,…)	9
5	Numerical integration, applications (mean value, …), Ordinary differential equations (first order equation, second order equation, Euler method, Implicit method, Predictor-Corrector methods, Runge-Kutta methods)	9
…	Partial differential equations (Finite difference method, Poisson equation, Schrödinger equation,	6
	Review	3
Total		45

Phys612: Advanced Quantum Mechanics

Course Objectives and Learning Outcomes

1. Course Description

The course covers the basic principles of Quantum formalism for closed systems, two-slit experiment. Schrödinger equation with spin (Pauli and Dirac equations) - Stern-Gerlach experiment. Quantum statistics, Theory of Angular Momentum and addition of two angular momentums-Approximation Methods, - Time-dependent Hamiltonian, quantum protocol and control; Time-dependent perturbation theory (Dyson method);, - Approximations (semi-classical analysis, WKBJ-method, Born-Oppenheimer approximation)., Open systems, dissipative evolutions, decoherence, Caldeira-Leggett model. Weak coupling (Fermi-Golden rule), Lindblad equation, - Quantum nature: superposition, entanglement, tunneling, nonlocality; Quantum optics. Jaynes-Cummings model, Rabi oscillations, coherent states, squeezing, manipulations of individual atoms;, -Depending on available time and taking into account the possible overlap with other course

2. Course Main Objective

- This course expands the knowledge of physics, providing deeper and fundamental insights into the research field you choose to focus on. In addition, there is a strong focus on providing you with the important practical skills you need to successfully perform experiments. Use perturbation theory (time independent or time dependent to resolve approximately Schrödinger equation: the Stark effect, Hyper fined split, harmonic oscillator and Zeeman effect.
- Demonstrate an understanding of angular momentum and addition of two momentums in quantum mechanics; Use different approximations methods , Undetstand many-particle Theory, Second Quantization theory and scattering theory: bosons and fermions

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	The students should be **familiar with** Quantum formalism for closed systems, two-slit experiment. Schrödinger equation with spin (Pauli and Dirac equations) - Stern-Gerlach experiment. Quantum statistics, Theory of Angular Momentum and addition of two angular momentums	a2
1.2	**Know** Approximation Methods, - Time-dependent Hamiltonian, quantum protocol and control	a2

CLOs		Aligned PLOs
1.3	**Recognize** - Time-dependent perturbation theory (Dyson method);, - Approximations (semi-classical analysis, WKBJ-method, Born-Oppenheimer approximation).,	a2
1.4	**Explain** Open systems, dissipative evolutions, decoherence, Caldeira-Leggett model. Weak coupling (Fermi-Golden rule), Lindblad equation, - Quantum nature: superposition, entanglement, tunneling, nonlocality	a2
2	**Skills :**	
2.1	**Capable of calculating** Jaynes-Cummings model, Rabi oscillations, coherent states, squeezing, manipulations of individual atoms;, -Depending on available time and taking into account the possible overlap with other courses	b2
2.2	**Analysis and calculation** path-integrals (example: Ahoronov-Bohm effect);, - From Einstein-Podolsky-Rosen experiments to Bell inequalities and the Kochen-Specker No-Go Theorems;	b2
2.3	**Solve various problems related to** Schroedinger's cat and possible solutions of the measurement problem	b2
3	**Competence:**	
3.1	Work in a group and learn time management.	c1
3.2	Learn how to search for information through library and internet.	c1
3.3	Present a short report in a written form and orally using appropriate scientific language	c1

Course Content

No	List of Topics	Contact Hours
1	Quantum formalism for closed systems, two-slit experiment. Schrödinger equation with spin (Pauli and Dirac equations) - Stern-Gerlach experiment. Quantum statistics, Theory of Angular Momentum and addition of two angular momentums	6
2	-Approximation Methods, - Time-dependent Hamiltonian, quantum protocol and control;,	6
3	- Time-dependent perturbation theory (Dyson method);, - Approximations (semi-classical analysis, WKBJ-method, Born-Oppenheimer approximation).,	6
4	- Open systems, dissipative evolutions, decoherence, Caldeira-Leggett model. Weak coupling (Fermi-Golden rule), Lindblad equation, - Quantum nature: superposition, entanglement, tunneling, nonlocality;	9
5	- Quantum optics. Jaynes-Cummings model, Rabi oscillations, coherent states, squeezing, manipulations of individual atoms;, -Depending on available time and taking into account the possible overlap with other courses	9

6	- Introduction to path-integrals (example: Ahoronov-Bohm effect);, - From Einstein-Podolsky-Rosen experiments to Bell inequalities and the Kochen-Specker No-Go Theorems;	6
7	- Schroedinger's cat and possible solutions of the measurement problem., Review	3
Total		45

Phys613: Electrodynamics

Course Objectives and Learning Outcomes

1. Course Description

Classical electrodynamics is important from both the fundamental and applied viewpoints. This course aims to provide students with an introduction to the principles and behaviours of dynamical electric and magnetic systems, and a theoretical foundation in classical field theory. The course will cover the classical electromagnetism in microscopic and macroscopic forms; electromagnetic fields of and forces between charged particles. Applications to electrostatic, magnetostatic, electrodynamic, and radiation problems.

2. Course Main Objective

- Use a range of mathematical techniques for solving challenging problems in electrodynamics.
- Create and interpret visual representations of electromagnetic fields and potentials.
- Gain physical insight from mathematical expressions of energy, momentum and charge conservation.
- Apply boundary conditions to solve reflection and transmission problems involving dielectric and conducting materials.
- Express scalar and vector potentials in different gauges, and use them to compute timedependent electromagnetic fields

Modern technology to understand Physics and physical phenomena is very important e.g. 1. Experimental or Theoretical Modeling 2. Equipment and Computer Interfacing to Collect and Process Data 3. Computer Simulations and Graphics 4. Research/Reference/Presentation, Reporting, and Displaying Information 5. Use of digital libraries like Saudi digital library (SDL)

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Understand origin of Maxwell's equations in magnetic and dielectric media.	K1

CLOs		Aligned-PLOs
1.2	Understand transport of energy and Poynting vector	K2
1.3	Understand transport of momentum, Maxwell stress tensor and radiation pressure	K3
1.4	Write down Maxwell's equations in linear, isotropic, homogeneous media	K4
1.5	Write down electromagnetic field tensor in covariant notation	K5
1...		
2	**Skills :**	
2.1	Derive continuity conditions on electromagnetic fields at boundaries	S1
2.2	Derive electromagnetic wave solutions and propagation in dielectric and other media	S2
2.3	Derive electromagnetic wave solutions and propagation in dielectric and other media	S3
2.4	Obtain scalar and vector potential equations in presence of sources,. Understand gauge invariance of Maxwell's equations	S4
2.5	decoupling of scalar and vector potential equations in Lorentz gauge and corresponding solutions	S5
2.6	Obtain Lorentz transformations for electric and magnetic fields and apply to simple cases	S6
2.7	Derive Lienard-Wiechert potentials for a moving point charge.	S7
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	C1
3.2	Use information technology and modern computer tools to locate and retrieve scientific information relevant to Electrodynamics	C2
3.3	Present a short report in a written form and orally using appropriate scientific language.	C3
3...		

Course Content

No	List of Topics	Contact Hours

1	Electrodynamics :Electromotive force ,Electromagnetic induction ,Maxwell's equations ,Maxwell's equations in matter ,Boundary conditions ,Conservation Laws : Charge and energy ,the continuity equations ,Poynting's theorem , Maxwell's stress tensor ,conservation of momentum	6
2	Potentials and Fields :Scalar and vector potentilas ,Gauge transformations , Coulomb Gauge and Lorentz Gauge ,Lienard -Wiechert Potentials ,The Fields of a Moving Point Charge., Radiation :Dipole Radiation ,Electric Dipole Radiation , Magnetic Dipole Radiation ,Power radiated by a point charge ,The mechanism responsible for radiation reaction,	6
3	Electrodynmaics and relativity :The Special Theory of Relativity ,The Lorentz Transfonnations ,Relativistic Energy and momentum ,Relativistic Kinematics , Magnetism as a Relativistic Phenomena ,How the Fields transorms , Electrodynanlics in Tensor Notation ,Relativistic Potentials, ,	6
Total		

Phys621: Advanced Nuclear Physics

Course Objectives and Learning Outcomes

1. Course Description

The following topics will be covered: Nuclear reactions: general description, Cross Sections, Qualitative features of nuclear reactions, Partial wave analysis, Classical and semi-classical descriptions of scattering, Direct reactions, Distorted-wave Born approximation, Inelastic scattering, Stripping and pick-up reactions, Knock-out reactions, Simple theory of a resonant cross-section, Resonances with charged particles.

2. Course Main Objective

The course gives an overview of the physical models which have been developed to account for the various aspects of nuclear reaction phenomena.

1. Annual review of the course using recent textbooks and references.
2. Electronic materials are updated frequently to support the lecture course.
3. Increase use of discussion workgroups.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Understand processes and phenomena in nuclear reactions.	Fundamental knowledge and interdisciplinary approach in physics;
1.2	Recognize classical and semi-classical descriptions of scattering.	
1.3	Describe transport of energy and Poynting vector.	identifying the key factors and applying appropriate principles and assumptions in the formulation of physics problems;
1...		
2	**Skills :**	
2.1	Analyze production and decay reactions for fundamental particles, applying conservation principles to determine the type of reaction taking place and the possible outcomes	Apply the theories and concepts of physics relations relating to the global research in local and international contexts;
2.2	Apply conservation laws to nuclear reactions and transform quantities between laboratory and centre-of-mass frames.	
2.3	choose the most appropriate and effective theoretical models, mathematical and numerical techniques, software packages and algorithms to solve non-standard problems in nuclear reactions.	Explain to a general audience, both other experts in the field and to people outside the field, physics concepts and results
2...	Compare and constrast different reaction mechanisms in relation to cross-sections, excitation functions, and angular distributions	
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	Work effectively in groups as well as individually
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to electrodynamics	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources
3...		

Course Content

No	List of Topics	Contact Hours
1	**Reaction mechanisms**: Types of nuclear reactions, Conserved Quantities in Nuclear Reactions, Reaction Kinematics, Nuclear Reactions Under Parity Conservation, Isospin in Nuclear Reactions, Exchange Symmetry in Nuclear Reactions of Identical Particles. Time-Reversal Invariance	6
2	**Cross Sections**: Rutherford Scattering, Rutherford Scattering Cross Section, Consequences of the Rutherford Experiments, Quantum-Mechanical Derivation of Rutherford's Formula, Deviations from the Rutherford Formula, Nuclear Radii from Deviations from Rutherford Scattering, Coulomb Scattering from an Extended Charge Distribution, Electron Scattering, Neutron Skins and Halo Nuclei.	6
3	**Qualitative features of nuclear reactions**: Compound nucleus formation and direct reactions, Compound resonances, Reaction times, Energy spectra, Branching ratios, Coulomb effects, Giant resonances and strength functions, Cross-section fluctuations, Some characteristics of heavy-ion reactions.	6
4	**Elementary Scattering Theory:** Form of the wave function, laboratory and centre-of-mass systems, the scattered waves, Differential cross-sections, coupled equations form of the Schrodinger equation, The Born and the distorted-wave Born approximations.	6
5	**Partial waves:** Significance of partial waves, Partial wave expansions, Scattering matrix and phase shifts, Phase shifts for potential scattering, Partial wave expression for scattering amplitudes, Partial wave expressions for cross-sections.	6
6	**Classical and semi-classical descriptions of scattering:** Classical elastic scattering of particles, Semi-classical treatments: The WKB approximation, The eikonal approximation	6
7	**Models of Nuclear Reactions:** (Direct reactions): Plane-wave Born approximation, Distorted-wave Born approximation, Inelastic scattering, Stripping and pick-up reactions, Knock-out reactions, (Compound-Nucleus (CN) Reactions): Simple theory of a resonant cross-section, Resonances with charged particles	9
Total		45

Phys622: Radiation Physics and Dosimetry

Course Objectives and Learning Outcomes

1. Course Description

Basic principles of radiation physics: radioactivity, the physics of ionizing radiation, radioactivity, x-ray production, interactions of radiation, radiation dosimetry, radiation exposure, dose deposition, radiation shielding, and radiation detectors. imaging equipment, radiation therapy equipment and The course will include lectures and demonstrations of clinical equipment applications. Provide a basic understanding of ionizing radiation. Course topics will include radiation detection, Course will also cover basic mathematical and physics concepts necessary in the understanding of the above topics.

2. Course Main Objective

- The course will cover basic mathematical and physics concepts necessary in understanding the following aims : Basic principles of radiation physics: radioactivity, the physics of ionizing radiation,
- Radioactivity, x-ray atteuation, quality, and production,
- Interactions of different kinds of radiation with matters, quality factors,
- Radiation dosimetry, radiation exposure, dose deposition,
- Radiation shielding, and radiation detectors.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Describe basic principles of radiation physics: radioactivity, the physics of ionizing radiation.	k1, k2
1.2	Describe x-ray production, interactions of radiation, radiation dosimetry, radiation exposure, dose deposition, radiation shielding, and radiation detectors.	
2	**Skills :**	
2.1	Apply the gained mathematical and experimental knowledge in any physical phenomena to understand its behavior.	s2
2.2	Solve the numerical problems with confidence.	
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	c1
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to radiation physics and dosimetry.	

Course Content

No	List of Topics	Contact Hours
1	Atomic and nuclear structure; Structure of Matter; Sources of radiation, Classification of radiation; quantities and units for radiation.	6
2	Radioactivity and radioactive decays, measurements of radioactivity and standards.	6
3	Interaction of radiation with matter, Photons: interaction and attenuation, attenuation coefficients; Interactions of neutrons; directly ionizing radiation; charged particle equilibrium (Particulate Radiation).	9
4	Radiation dosimetry, Radiation Detection; Cavity theory and ionization chambers.	6
5	In vivo dosimetry, Radiation dosimetry; Radiation Shielding, Medical physics equipment.	6
6	X-rays: Properties and Interactions; Quality of x-rays; production.	6
7	Introduction to radiation detectors, Radiation Detection, Exposure and Dose; Equipment demonstration.	6
Total		45

Phys623: Statistical Physics

Course Objectives and Learning Outcomes

1. Course Description

Statistical physics is witnessing a revolution: understanding the dynamics of a very large number of interactive degrees of freedom, which has been from the beginning the main aim of statistical physics, has become now a central problem in many fields such as physics, biology, computer science, just to cite a few. Now more than ever, statistical physics is both for its methods and its applications a very powerful discipline with a very broad range of theoretical methods and ramifications in many branches of science.

The aim of this series of lectures is facing the students with this very rich state of the art: on one hand by teaching fundamental notions and methods of statistical physics and at the same time by presenting its modern applications in physics and beyond.

2. Course Main Objective

Modern technology to understand Physics and physical phenomena is very important e.g.

1. Experimental or Theoretical Modeling
2. Equipment and Computer Interfacing to Collect and Process Data
3. Computer Simulations and Graphics
4. Research/Reference/Presentation, Reporting, and Displaying Information

5.	Use of digital libraries like Saudi digital library (SDL)

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Define and discuss the basic concepts and physics of statistical mechanics.	Fundamental knowledge and interdisciplinary approach in physics;
1.2	Review of the principles of statistical mechanics: microcanonical ensemble, canonical ensemble, grand canonical ensemble. Maximum entropy principle.	
2	**Skills :**	
2.1	apply statistical physics to predict the mechanical and dynamical properties and to explain phase behavior of physical systems.	Apply the theories and concepts of physics relations relating to the global research in local and international contexts;
2.2	use simple physical models to illustrate the fundamental ideas of thermodynamics and statistical mechanics.	
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	Work effectively in groups as well as individually
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to electrodynamics	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources
3...		

Course Content

No	List of Topics	Contact Hours
1	Review of equilibrium thermodynamics: first law and equilibrium, second law, thermal equilibrium and temperature, phase transitions.	3
2	Review of the principles of statistical mechanics: microcanonical ensemble, canonical ensemble, grand canonical ensemble. Maximum entropy principle.	3
3	Phase transitions: Ising model, lattice gas, broken symmetry and range of correlations, Ising model in one dimension, mean field theory, Landau theory of phase transitions, critical exponents, scaling, renormalization group theory, Ising model in two dimensions.	4
4	Statistical mechanics of non-equilibrium systems: systems close to equilibrium, Onsager's regression hypothesis and time correlation functions, fluctuation-	5

	dissipation theorem, response function, Brownian motion, Langevin Equation, Fokker-Planck equation, master equation and detailed balance, systems far from equilibrium, the concepts of work and heat revisited, the fluctuation theorems.	
Total		

Phys624: Physics and Technology of Semiconductors

Course Objectives and Learning Outcomes

1. Course Description

The course introduces the important physics underlying semiconductor materials and devices. Discusses methods for phenomena and behavior of semiconductors and introduces the key technological important mechanism that count in optimization of devices.

2. Course Main Objective

- Provide the student with a detailed understanding of the principles and operation of semiconductor devices
- Enable the student to understand the methods by which semiconductors may be produced and characterised
- Illustrate how groundbreaking physics has led to advanced technologies

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Back ground and development of fundamental knowledge in Physics	Fundamental knowledge and interdisciplinary approach in Physics.
1.2	Fundamental knowledge and mathematical approach in Physics	
1.3	To understand the Physics conceptus at an advanced level for solving complex problems.	
1.4	Identifying the key factors and applying appropriate principles and assumptions in the formulation of Physics problems	
2	**Skills :**	
2.1	Perform data analysis and draw results and conclusions	Apply and explain the theory and experimental data to concepts of Physics.
2.2	Apply the Physics theories and draw relations with research on related topics	
2.3	Ability to use analytical and/or computational methods to solve physics problems;	
2...	Explain to a general audience and experts in the field with concepts and results	
3	**Competence:**	
3.1	Applying appropriate scientific programming skills;	Use the appropriate tools and acquire requisite information from diverse sources
3.2	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources	
3.3	Having good time management skills.	

CLOs		Aligned PLOs
3.4.	Work effectivily in group	Work effectively in groups as well as individually

Course Content

No	List of Topics	Contact Hours
1	INTRODUCTION TO SEMICONDUCTOR : Classification of Semiconductor	3
2	SEMICONDUCTOR BONDING: Empirical Evidence of Semiconductor bonding, Hybridization of Group IV Elements	3
3	ENERGY BANDS: One Electron Model, Bloch Theorem, Reduced zone Scheme for representing energy bands,	3
4	Empty Lattice Band Structure, Effect of Filling the Empty Lattice,	3
5	Qualitative Band Shapes of the Diamond Lattice, Zinc–Blende,	3
6	Spin-Dependent Effects, Energy Band Calculations, Temperature Dependence of Bands,	3
7	Effective Mass & Crystal Momentum, Constant Energy Surfaces.	3
8	DENSITY OF STATES: MANY – VALLEY MODEL: Semiconductor Statistics, Intrinsic Semiconductors, Electron Hole Statistics, Intrinsic Case, Boltzmann Approximation (Non-degeneration Semiconductor),	3
9	Law of Mass Action, Extrinsic Semiconductors, Picture of an Impurity, EMT or Hydrogenic Model.	3
10	TRANSPORT PROPERTIES: Charge-Carrier Transport, Electrical Conductivity:, One – valley Model, Effect of Electric Field: on a single electron – Zener Oscillations in an otherwise empty band.	3
11	BOLTZMANN TRANSPORT EQUATION: Relaxation Time Approximation, Charge Transport, Spherical Energy Surfaces – one Valley Model,	3
12	Transform the Current Integral to Energy Space, Non-degenerate Semiconductors with one – valley: Degenerate Semiconductors, Complete Expression for Conductivity in the one-valley Model: Many – Valley Semiconductors.	3
13	IMPURITY SCATTERING: Ionized Impurity Scattering, Neutral impurity scattering, Lattice Scattering.	3
14	Review	3
...	Examinations	3

Total	42

Phys625: Characterization of Advanced Materials

Course Objectives and Learning Outcomes

1. Course Description

In order to introduce the fundamentals of experimental physics to the students, a comprehensive course on basic experimental techniques including synthesis of advanced materials, their processing, characterization and data manipulation is required. The students become familiar with various techniques that can be used for study of materials from fabrication to characterization and applications. The students will be exposed to the basic idea of synthesis via different routes. The characterization techniques for the analysis of various fabricated nanoparticles will be overviewed. Finally a section will be devoted to the data acquisition and error analysis.

2. Course Main Objective

- The purpose of the course is to prepare the students for research in the field of experimental physics.
- In this course, students can utilize their knowledge in various fields of interest such as nanotechnology, plasma physics, experimental laser physics, and electronics etc.
- Awareness about thin film Physics and its preparation methods.
- Awareness about structural, electronic, optical, and thermal characterization techniques.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Understand about: ▪ Experimental methods and problems ▪ Experimental parameters ▪ Reproducibility of Data ▪ Data and error analysis	Fundamental knowledge and interdisciplinary approach in Physics.
1.2	Understand the Principle and objectives of Etching methods	

CLOs		Aligned-PLOs
2	**Skills :**	
2.1	Apply diffraction techniques to know about crystal structure.	Apply the theory and experimental concepts of Physics.
2.2	Use SEM and EDX to study the morphology and elemental compositions.	
2.3	Use optical techniques to study the optical properties of the nanostructures.	
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	Work effectively in groups as well as individually
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to electrodynamics	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources
3...		

Course Content

No	List of Topics	Contact Hours
1	Overview of Characterization of Advanced Materials: Experimental methods and problems, Experimental skills and design, Design of Experiment, Experimental parameters, Reproducibility of Data, Data and error analysis: Uncertainties and measurements	6
2	Principle and objectives of Etching methods, Characterizations in Physics: Physical Characterization of Materials (Bulk characterizations, Surface characterizations), Requirements of Characterizations (Kinetic theory concept of elements)	6
3	Diffraction techniques: Experimental methods for X-rays structure determination, Properties of X-rays, Experimental methods and crystal determination techniques., Optical Microscopy: Principle and objectives of optical microscopy	9
4	Electron Microscopy: Principle and objectives of SEM, EDX, Thermal Analysis: Principle and objectives of Differential scanning calorimetry (DSC)	9
5	Optical properties: Principle and objectives of Photoluminescence spectroscopy, Principle and objectives of FTIR spectroscopy, Principle and objectives of UV-Visible	12
6	Review	3
Total		45

Phys630: Research Methodology

Course Objectives and Learning Outcomes

1. Course Description

The purpose of the course is to prepare the students for research in the field of amorphous materials.
to understand the theories deal with the formation of amorphous materials including their structure.
Modern technology to understand Physics and physical phenomena is very important e.g.
Experimental or Theoretical Modeling
Equipment and Computer Interfacing to Collect and Process Data
Computer Simulations and Graphics
Research/Reference/Presentation, Reporting, and Displaying Information
Use of digital libraries like Saudi digital library (SDL)

2. Course Main Objective

1. **The definition of research and the scientific method.**
2. **The terminology used in scientific research.**
3. **The planning of research.**
4. **The data collection methods. The validity and reliability.**
5. **The data analysis**

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	**Understand research and scientific methods.**	Fundamental knowledge and interdisciplinary approach in physics;
1.2	**Statistical error calculation and research ethics.**	
1.3	**Research design, planning, sampling, validity and reliability.**	identifying the key factors and applying appropriate principles and assumptions in the formulation of physics problems;
1...		
2	**Skills :**	
2.1	**Analyze writing research proposal and the possible outcomes**	Apply the theories and concepts of physics relations relating to the global research in local and international contexts;
2.2	**Reviewing the Literature.**	
2.3	**Experimental methods, data collection and evaluation of research.**	Explain to a general audience, both other experts in the field and to people outside the field, physics concepts and results
2...	**Data analysis.**	

CLOs		Aligned-PLOs
3	Competence:	
3.1	Work effectively in groups as well as individuals.	Work effectively in groups as well as individually
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to solid state.	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources
3...		

Course Content

No	List of Topics	Contact Hours
1	Course introduction and course distribution. Research definition, research types and scientific methods.	6
2	Research design, planning, sampling, validity and reliability. Writing research proposal.	6
3	Reviewing the Literature. Experimental methods, data collection and evaluation of research.	6
4	Quantitative and qualitative data analysis.	6
5	Correlation between the analyzed data and previous research works.	6
6	Discussion and explanation of results.	6
7	Review	9
Total		45

Phys631: Applications of Ionizing Radiation Physics

Course Objectives and Learning Outcomes

1. Course Description

The basic principles of ionizing radiation, x-ray production, interactions of radiation, imaging equipment, radiation therapy equipment and the course will include lectures and demonstrations of clinical equipment applications. Provide a basic understanding of ionizing radiation. Course will also cover basic mathematical and physics concepts necessary in the understanding of the above topics. To achieve an understanding of medical X-ray and gamma ray imaging technology in terms of equipment components and their performance and to relate this to the needs of diagnostic medical imaging. To give the student a broad overview of the techniques used *in-vivo* and *in-vitro* nuclear medicine studies. To provide an overview of the use of radiopharmaceuticals in nuclear medicine. An appreciation of quality management, its aims and application to imaging and radiotherapy.

2. Course Main Objective

- The course will cover basic mathematical and physics concepts necessary in understanding the basic principles of ionizing radiation physics.
- Application of ionizing radiation for diagnostic and therapeutic purposes.
- An introduction is given to imaging systems: X-radiography, gamma cameras, X-ray computed tomography, single photon computer tomography (SPECT) and positron emission tomography (PET).
- An overview is given of radiotherapy techniques and the biological processes concomitant with this modality together with discussion of isodose curves and variation with incident radiation energy.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Describe basic principles of ionizing radiation physics.	k1, k2
1.2	Describe Application of ionizing radiation for diagnostic and therapeutic purposes.	
1.3		
1...		
2	**Skills :**	
2.1	Apply the gained mathematical and experimental knowledge in any physical phenomena to understand its behavior.	s2
2.2	Solve the numerical problems with confidence.	
2.3		
2...		
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	c1
3.2	Present a short report in a written form and orally using appropriate scientific language.	

	CLOs	Aligned-PLOs
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to radiation physics and dosimetry.	
3...		

Course Content

No	List of Topics	Contact Hours
1	Introduction to ionizing radiation and its classification, and sources; principal of applications: tracer concept, scattering and attenuation of radiation, radiation processing of materials;	6
2	Applications: 1. Health-care: Diagnostic application: Radioimmunoassay (RIA) and Related technique; Diagnostic nuclear medicine: Radiopharmaceuticals, Diagnostic techniques and its applications: Radiology: Single photon emission computed tomography (SPECT), Positron emission tomography (PET), X-rays, computed tomography (CT) Scan, therapeutic application: Radionuclide therapy, Radiotherapy. Risk/benefit analysis in mammography. Elements of the mammographic imaging system: dedicated X-ray sets, films, intensifying screens and film processing systems. Introduction to digital imaging modalities and their applications in mammography; Isodose curves and variation with incident radiation energy.	15
3	Applications: 2. Agriculture and industry: application in food and agricultural products: Food preservation; industry: radiation processing, non-destructive testing, radiotracer techniques, Facilities and devices for the application of nuclear techniques.	9
4	3. Application in Biology: Radiotracer, labeling methods; Labeled probe applications: In situ hybridization (ISH), DNA finger printing, molecular diagnostics, drug discovery.	6
5	Applications: 4. Environmental studies and Pollution control.	3
6	**X-rays, γ-rays, Modulation Transfer Function (MTF) and Receiver Operating Characteristic (ROC) Analysis:** Mathematical formulation of the imaging system; linear operator, principle of superposition, impulse response function, stationarity, line spread function, edge spread function, convolution integral, MTF. Usefulness of MTF, modulation input and output, measure of performance, cascade MTFs. Visual acuity, resolution criteria. Existence of observer, decision criteria, confidence thresholds, conditional	6

	probabilities, types of decision. Construction of the ROC curve and principle of ROC analysis.	
7		
Total		45

Phys632: Radiation Detection and Measurements

Course Objectives and Learning Outcomes

1. Course Description:

The course provides theoretical knowledge of the detection of ionizing radiation and a good knowledge on measurement techniques. The course covers the measurement of small currents and charges, pulse height analysis, statistics and dead time corrections. Gas, scintillation and semiconductor detectors are also treated, as well as neutron detectors. The course also covers gamma and alpha/beta spectrometry technique as well as the dosimeters and the calorimeter detectors.

2. Course Main Objective:

The main objectives are:
- Demonstrate an understanding of the principles of radiation detection and measurement as well as the used nuclear instruments.
- Gaining knowledge and skills on radiation detection, counting and spectrometry including shielding and health physics, as well as in radioactive sample preparation.
- Demonstrate an ability to understanding how to acquire, identify, quantify and assess radionuclides and report radiation data, uncertainty and detection limits.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Understand of the role of fundamental processes involved with the interaction of x- and gamma-ray photons, charged particles and neutrons with matter.	k1
1.2	Detailed knowledge of the principles of operation of solid state semi-conductor detectors, scintillation counters, gas ionization detectors	k1, k2
1.3		
1...		
2	**Skills :**	
2.1	- Collect general information about radiation detection and technique of measurements.	s2

CLOs		Aligned-PLOs
2.2	- Use the mathematical equations in understanding particles interactions.	s2
2.3	- Apply the gained mathematical and experimental knowledge in any physical related topic.	s2
2...		
3	**Competence:**	
3.1	Learn how to search information through library	c2, c5

Course Content

No	List of Topics	Contact Hours
1	Radiation sources, interactions of particles (Heavy charged particles, electrons, neutrons, Gamma rays) with matter, Radiation Exposure and Dose	6
2	General properties of radiation detectors: Simplified Detector Model, Modes of Detector Operation, Pulse Height Spectra, Counting Curves and Plateaus, Energy Resolution, Detection Efficiency, dead time.	3
3	Counting statistics and error analysis: Characterization of data, Statistical models, Applications of statistical models, Limits of detectability, Distribution of time intervals.	6
4	Action of gas filled ionization chamber and proportional counters, gas multiplication; ion mobility, recombination, pulsed and direct current modes of operation; Geiger-Muller counter, internal and external quenching, practical devices	9
5	Scintillation counting with gases, liquids and solids; theory of operation, selection for various applications.	6
6	Semiconductor detectors (HPGe detector), Configurations of Germanium detectors, Germanium detector operational characteristics, Gamma-Ray spectrometry technique.	6
7	Dosimeters, calorimeters, chemical dosimetry, gas dosimetry, W-values, stopping power ratio.	3
8	Neutron activation, Neutron detection, fission track detectors, neutron spectrometry.	6
Total		45

Phys633: Detectors Instrumentation

Course Objectives and Learning Outcomes

1. Course Description

Topics will include the performance and use of preamplifiers, spectroscopy systems and multi-channel analyzers (MCAs). Digital methods for data acquisition, including digital pulse processing, pulse shape discrimination and digital MCA systems. Instrumentation for scintillators and gas detectors. The module will also cover digital signal processing and the role of noise in affecting detector performance.

2. Course Main Objective

- This course is designed to understand detectors instrumentation, its working and design for the radiation measurements. The course will cover basic mathematical and physics concepts necessary in understanding the basic principles of detector instrumentation.
- This module explores the theory of operation and practical aspects of instrumentation for radiation detection, covering both traditional analogue instrumentation techniques and the latest developments in digital pulse processing. Students will also critically evaluate the role of statistical processes in detector noise and electronic signal processing.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Describe instrumentation for radiation detectors and signal processing.	k1, k2
1.2	Describe nuclear electronics, data collection and its analysis.	
1.3		
1...		
2	**Skills :**	
2.1	Apply the gained mathematical and experimental knowledge in any physical phenomena to understand its behavior.	s2
2.2	Solve the numerical problems with confidence.	
2.3		
2...		
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	c1
3.2	Present a short report in a written form and orally using appropriate scientific language.	

CLOs		Aligned-PLOs
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to radiation physics and dosimetry.	
3...		

Course Content

No	List of Topics	Contact Hours
1	INTERACTION OF RADIATION WITH MATTER: A survey, IMPORTANT FEATURES OF RADIATION DETECTORS: Modes of detector operation, Counting curves and plateaus, Energy resolution, Calibration and Detection efficiency, Dead time, Quenching.	9
2	DETECTORS FOR NUCLEAR PARTICLES: Gas filled Detectors: Ionization chamber, Proportional counter, GM counter; Scintillation detectors; Semi-conductor detectors: HPGe detector: - Design and operation.	6
3	PARTICLE ACCELERATORS: Van de Graaff generator, Pelletron Accelerator; Linear Accelerators (LINAC), Cyclotron, Microtron, Betatron, Synchrotron: - Design and operation.	6
4	LINEAR AND LOGIC PULSE FUNCTIONS: Linear and Logic Pulses, Instrument Standards, Application Specific Integrated Circuits (ASICs), Summary of Pulse-Processing Units, Components Common to Many Applications, Pulse Counting Systems, Pulse Height Analysis Systems, Digital Pulse Processing, Systems Involving Pulse Timing, Pulse Shape Discrimination.	9
5	MULTICHANNEL PULSE ANALYSIS: Single-Channel Methods, General Multichannel Characteristics, The Multichannel Analyzer, Spectrum Stabilization and Relocation, Spectrum Analysis.	6
6	DATA ANALYSIS AND TECHNIQUES: Counting statistics and error predictions: Characterization of data, Statistical models and their applications, Chi-square test, Precision and accuracy, Error analysis, propagation of errors, Limits of detectability, Plotting of graphs, Least squares fitting, linear and nonlinear curve fitting, Poisson statistics, Fourier analysis.	9
7		
Total		45

Phys634: Radiation Protection

Course Objectives and Learning Outcomes

1. Course Description

1. What is the main purpose for this course?

This course describes the international legislative framework of radiation protection. From this starting point the course covers population and personal exposures to radiation, the principles of dose calculations, and example procedures for implementing radiation protection programmes

2. Briefly describe any plans for developing and improving the course that are being implemented. (e.g. increased use of IT or web based reference material, changes in content as a result of new research in the field)

- Annual review of the course using recent textbooks and others references.
- Electronic materials are updated frequently to support the lecture course.

2. Course Main Objective

The course gives a thorough understanding of the underlying philosophy and the practical implementation of the ICRP system of radiological protection. To encourage a quantitative approach to radiological protection; and to illustrate the need for a detailed understanding of the sources of radiation exposure and methods for applying the principles of radiation protection.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	knowledge of the fundamental principles for radiation protection	K1
1.2	basic knowledge of the origin of radiation, properties and biological impact	K2
1.3	knowledge of risks when working with radiation and how these risks relate to other risks in the society	K3
1.4	basic knowledge and skills in using radiation protection instruments	K4
2	**Skills :**	
2.1	Analysis of data to gain ability to perform simplified dose calculations	S1
2.2	Ability to understand the methods for applying the principles of radiation protection	S2
2.3		
2...		
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	C1
3.2	Present a short report in a written form and orally using appropriate scientific language.	C2
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to electrodynamics	C3
3...		

Course Content

No	List of Topics	Contact Hours
1	Quantities and measurements: Radiation field; fluence (rate); energy fluence (rate), mass attenuation coefficient; mass stopping power, Exposure (rate); kerma (rate); energy imparted; absorbed dose (rate); organ dose, Equivalent dose (rate); radiation weighting factor (wR); Effective dose, tissue weighting factor (wT).	6
2	The history of radiation protection. Radiation risks. The ICRP system of radiological protection. Future recommendations of the ICRP	6
3	Basic Safety Standards, Ionizing Radiations	6
4	First Mid-term Exam	2
5	Environmental radiation, natural sources, man-made sources and population exposures	3
6	Practical Radiation Protection, Radiation shielding. Gamma-ray attenuation and buildup processes. Point kernel calculations and their application to extended sources	6
7	Assessment of radiological risks	3
8	Second Mid-term Exam	2
9	Nuclear Industry Safety Case Principles	3
10	Phases of decommissioning, radiation sources and controls, options and assessment methods, economic considerations and examples Waste management and disposal, categorization and arising, disposal routes, inventory management and assay techniques	6
11	Final Exam	2
Total		45

Phys635: Heat Transfer in Microelectronics devices

Course Objectives and Learning Outcomes

1. Course Description

Introduction to nano heat transfer,
Boltzmann Equation for Phonon Transport;
Single and dual phase lag models;
Application to nanoscale heat transfer, Heat transfer in transistors

Introduction to heat transfer, Overview on heat transfer mechanisms, Conduction, Convection, Radiation Laws of macroscopic heat transfer; Heat Conduction in solids, Fourier law, Heat equation, Thermal resistance, Lumped capacity, Harmonic Cconduction regime, Limit of Fourier law; Transport in dilute medias, Distribution function, Boltzmann equation, Collision, Relaxatio, Mean free path, Knudsen number, Various transport regimes (ballistic, semi-ballistic and diffusive); Electrons and Phonons, Electrical conduction, Semi-classical approach, Electrical conductivity in the collisional regime, Electrical conduction in the ballistic regime, Vibrational modes in a lattice, Density of states, Optical and acoustic modes, Heat Flux, Heat capacity; Solution of the Boltzmann Equation for Phonon Transport; Single and dual phase lag models; Application to nanoscale heat transfer, Heat transfer in transistors

2. Course Main Objective

Introduction to nano heat transfer,
Boltzmann Equation for Phonon Transport;
Single and dual phase lag models;
Application to nanoscale heat transfer, Heat transfer in transistors

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	nano heat transfer	
1.2		
1.3		
1...		
2	**Skills :**	
2.1		
2.2	Boltzmann Equation for Phonon Transport	
2.3	Single and dual phase lag models	
2...		
3	**Competence:**	
3.1		
3.2	Application to nanoscale heat transfer, Heat transfer in transistors	
3.3		
3...		

Course Content

No	List of Topics	Contact Hours

1	Introduction to heat transfer, Overview on heat transfer mechanisms, Conduction, Convection, Radiation, Laws of macroscopic heat transfer	12
2	Transport in dilute medias, Distribution function, Boltzmann equation, Collision, Relaxatio, Mean free path, Knudsen number, Various transport regimes (ballistic, semi-ballistic and diffusive), Electrons and Phonons, Electrical Conduction, Semi-classical approach, Electrical conductivity in the collisional regime, Electrical conduction in the ballistic regime, Vibrational modes in a lattice, Density of states, Optical and acoustic modes, Heat Fl,	12
3	Solution of the Boltzmann Equation for Phonon Transport, Single and dual phase lag models,	12
4	Application to nanoscale heat transfer, Heat transfer in transistors.,	9
Total		45

Phys636: Solar Cells

Course Objectives and Learning Outcomes

1. Course Description

Aim of this course is to provide some understanding to students about that how solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated, what technologies are currently on the market, and how to evaluate the risk and potential of existing and emerging solar cell technologies. We will also try examine the potential & drawbacks of currently manufactured technologies (single- and multi-crystalline silicon, tandem cells, CdTe, CIGS, CPV, PVT), as well as pre-commercial technologies (organics, biomimetic, organic/inorganic hybrid, and nanostructure-based solar cells).

2. Course Main Objective

- By the year 2030, several hundred gigawatts of power must be generated from low-carbon sources to cap atmospheric CO2 concentrations at levels deemed "lower-risk" by the current scientific consensus.
- The necessity to develop low-carbon energy sources represents not only an awesome technological and engineering challenge, but also an equally large economic opportunity in a trillion-dollar energy market.
- Student can describe Fundamentals of photoelectric conversion into elecreical energy. They know about an overview of world energy requirement and its resources
- The students are expected to understand physical properties and working principal s of Solar cells and have an idea how to improve the efficiency of solar cells

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Back ground and development of fundamental knowledge in Physics	Fundamental knowledge and interdisciplinary approach in Physics.
1.2	Fundamental knowledge and mathematical approach in Physics	
1.3	To understand the Physics conceptus at an advanced level for solving complex problems.	
1.4	Identifying the key factors and applying appropriate principles and assumptions in the formulation of Physics problems	
2	**Skills :**	
2.1	Perform data analysis and draw results and conclusions	Apply and explain the theory and experimental data to concepts of Physics.
2.2	Apply the Physics theories and draw relations with research on related topics	
2.3	Ability to use analytical and/or computational methods to solve physics problems;	
2...	Explain to a general audience and experts in the field with concepts and results	
3	**Competence:**	
3.1	Applying appropriate scientific programming skills;	Use the appropriate tools and acquire requisite information from diverse sources
3.2	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources	
3.3	Having good time management skills.	Work effectively in groups as well as individually
3.4.	Work effectivily in group	

Course Content

No	List of Topics	Contact Hours
1	PHOTOVOLTAIC: Fundamentals of photoelectric conversion: charge excitation, conduction, separation, and collection. Commercial and emerging photovoltaic (PV) technologies. Cross-cutting themes in PV: conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, risk analysis.	3
2	Photovoltaic technology evolution in the context of markets, policies, society, and environment. Overview of world energy, Options for harnessing solar energy and their respective current and projected costs/potential, compared to traditional sources.	3
3	Minority carrier mobility, lifetime, diffusion length. Charge excitation in non-semiconducting materials. Conduction, dispersive hopping.	3

4	CHARGE SEPARATION: How voltage, current are formed. Minority-carrier devices: semiconductor pn-junctions.	3
5	IV curves. Majority-carrier devices (organics). Quantum-size effects of charge separation.	3
6	CHARGE COLLECTION, AND THE SOLAR CELL DEVICE: Metallization. Solar cell device architectures.	3
7	Common limitations of efficiency, short-circuit current, fill factor, open-circuit voltage.	3
8	COMMERCIAL TECHNOLOGIES-I : Crystalline silicon solar cells, Crystal growth: ingot silicon, ribbon and sheet silicon. Wafering. Cell fabrication: methods, architectures, concepts.	3
9	History, state-of-the-art. Emerging trends, cutting-edge technology. Role of innovation.	3
10	COMMERCIAL TECHNOLOGIES-II: Thin Films: thin film silicon (incl. amorphous, SiGe, micromorph, tandem cells), cadmium telluride, copper indium gallium diselenide.	3
11	Precursors. Deposition processes and technologies. Other technologies: concentrator devices and materials, heterojunction devices, photovoltaic thermal.	3
12	DEVELOPING TECHNOLOGIES: Organic PV. Organic/Inorganic hybrid systems (dye-sensitized, nano hybrid). Inorganic nanostructured materials, incl. quantum dots, nanostructured devices, and layered structures. Biological and biomimetic systems. Novel thin film materials, multiband semiconductors, hot carrier devices, spectrum splitting.	3
13	PHOTOELECTRIC CONVERSION EFFICIENCY: Theoretical efficiency limits. Efficiency loss mechanisms. Optical losses, recombination losses, surface recombination velocity, series and parallel resistance (shunts).Specific loss mechanisms in each technology class. Evaluation of loss mechanisms, common characterization tools.	3
14	Review	3
...	Examinations	3
Total		42

Phys637: Non-Crystalline materials

Course Objectives and Learning Outcomes

1. Course Description
The purpose of the course is to prepare the students for research in the field of amorphous materials. **to understand the theories deal with the formation of amorphous materials including their structure.** **to understand the preparation of the different types of amorphous materials.** **to understand how to characterize with different techniques the amorphous materials.** **to understand the theoretical approaches of the properties of the amorphous materials.**
2. Course Main Objective
1. Current technology to understand Physics of amorphous materials is very important e.g. 2. Experiments of preparation the non-crystalline materials 3. Equipment and Computer Interfacing to Collect and Process Data 4. Computer Simulations and Graphics 5. Research/Reference/Presentation, Reporting, and Displaying Information 6. Use of digital libraries like Saudi digital library (SDL)

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Understand processes and phenomena in amorphous materials.	Fundamental knowledge and interdisciplinary approach in physics;
1.2	Recognize theories of amorphous structure.	
1.3	Describe features of physical characteristics of glasses.	identifying the key factors and applying appropriate principles and assumptions in the formulation of physics problems;
1...		
2	**Skills :**	
2.1	Analyze structure and formation of inorganic glass and polymers by applying techniques and theoretical studies to determine the mechanical and electrical properties of glasses and the possible outcomes	Apply the theories and concepts of physics relations relating to the global research in local and international contexts;
2.2	Apply the use of rare earth oxides in glasses to study their future applications.	
2.3	Choose the most appropriate and effective theoretical models, mathematical and numerical techniques, software packages	Explain to a general audience, both other experts in the field

CLOs		Aligned-PLOs
	and algorithms to solve non-standard problems of the amorphous structure.	and to people outside the field, physics concepts and results
2...	Compare the use of Judd-Ofelt theory and the other models deals with the electronic transitions in the amorphous structure.	
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	Work effectively in groups as well as individually
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to solid state.	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources
3...		

Course Content

No	List of Topics	Contact Hours
1	Introduction to glasses and their characteristization.	6
2	Different types of glasses: Structure, Formation and method of preparations.	6
3	Optical behaviors of dopants and defects in glasses and polymers..	6
4	Mechanical properties of glasses including theoretical approaches.	6
5	Thermal properties of glasses including theoretical models.	6
6	Electrical properties including Ac and DC conductivity along with theories such as polaron theory.	6
7	The use of amorphouse materials as smart materials and their future uses in optical filters, sensors and data storage.	9
Total		45

Phys638: Nanostructures Engineering

Course Objectives and Learning Outcomes

1. Course Description

This course introduces the theory and technology of micro/nano fabrication. Lectures sessions focus on basic processing techniques such as diffusion, oxidation, photolithography, chemical vapor deposition, and more.Through lab assignments (group), students are expected to gain an understanding of these processing techniques, and how they are applied in concert to device fabrication. Students enrolled in this course have a unique opportunity to test micro/nano-devices, using modern techniques and technology.

2. Course Main Objective

- This course introduces the theory and technology of micro/nano fabrication.
- Lectures sessions focus on basic processing techniques such as diffusion, oxidation, photolithography, chemical vapor deposition, and more.
- Through lab assignments (group), students are expected to gain an understanding of these processing techniques, and how they are applied in concert to device fabrication.
- Students enrolled in this course have a unique opportunity to test micro/nano-devices, using modern techniques and technology.

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	Back ground and development of fundamental knowledge in Physics	Fundamental knowledge and interdisciplinary approach in Physics.
1.2	Fundamental knowledge and mathematical approach in Physics	
1.3	To understand the Physics conceptus at an advanced level for solving complex problems.	
1.4	Identifying the key factors and applying appropriate principles and assumptions in the formulation of Physics problems	
2	**Skills :**	
2.1	Perform data analysis and draw results and conclusions	Apply and explain the theory and experimental data to concepts of Physics.
2.2	Apply the Physics theories and draw relations with research on related topics	
2.3	Ability to use analytical and/or computational methods to solve physics problems;	
2...	Explain to a general audience and experts in the field with concepts and results	
3	**Competence:**	
3.1	Applying appropriate scientific programming skills;	Use the appropriate tools and acquire requisite information from diverse sources
3.2	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and information from diverse sources	
3.3	Having good time management skills.	Work effectively in groups as well as individually
3.4.	Work effectivily in group	

Course Content

No	List of Topics	Contact Hours
1	IMPORTANCE OF NANOSCIENCE: Structures 1-100 nm in size, Quantum effects in nanostructure, Catalysis, Colours from colloidal nanostructures,	3
2	Moore's law, Spintronics, Biological systems	3
3	Buckyballs, Quantum dots, One dimensional systems: Metallic nanowires and quantum conductance, Carbon nanotubes and dependence on chirality,	3
4	Two dimensional systems: Quantum wells and modulation doping, Resonant tunnelling	3
5	OPTICAL PROPERTIES: Two dimensional systems (quantum wells), Absorption spectra, Excitons, Coupled wells and superlattices,	3
6	Quantum confined Stark effect, Quantum cascade laser, One dimensional systems (quantum dots)	3
7	MAGNETIC PROPERTIES: Transport in a magnetic field: Quantum Hall effect, Spin valves, Spin-tunnelling junctions, Domain pinning at constricted geometries, Magnetic vortices	3
8	FABRICATION OF NANOSCALE MATERIALS: TOP-DOWN VS BOTTOM-UP: Thin film deposition,	3
9	Epitaxial growth, CVD, MBE, plasma,	3
10	Lithographic, photo, e-beam, Etching, FIB,	3
11	Synthesis, Colloidal dispersions, Atomic and molecular manipulations, Self assembly: Growth modes, Stransky-Krastinov etc, Ostwald ripening	3
12	CHARACTERISATION OF NANOSTRUCTURS: Beam probe methods: TEM, EDX, EELS, SEM, EDX, X-ray scattering, Neutron scattering,	3
13	Scanning probe methods: STM, STS, spin-polarised STM, AFM, MFM, EFM, Other: Optical spectroscopy, Chromatography, Light scattering, Photoemission	3
14	Review	3
…	Examinations	3
Total		42

Phys640: Optical Properties of Nanostructures

Course Objectives and Learning Outcomes

1. Course Description

The course will cover the optical physics of semiconductors nanostructures. The course includes the quantum theory of the absorption and luminescence phenomena in semiconductors nanostructures. The exciton effects will be addressed. Quantum confinement of quantum well and nanostructure semiconductors will be covered including a brief description of luminescence centers of some metallic dopants in semiconductors nanostructures. The quantum theory treatment of luminescence related to phonon absorption will be included. The course will be ended by a brief introduction to nonlinear crystals and optical properties of new semiconductor materials.

2. Course Main Objective

- The purpose of the course is to prepare the students for research in the field of experimental physics.
- to understand the quantum theory of absorption and emission in semiconductor including defects and excitonic effects.
- to understand the effect of quantum confinement in nanostructural semiconductors nanostructures.
- to understand the complex optical phenomena related to optical centers and phonon absorptions.
- to understand the nonlinear optical properties

Course Learning Outcomes

	CLOs	Aligned-PLOs
1	**Knowledge:**	
1.1	To know the optical absorption in semiconductor nanostructures, luminescence in semiconductors nanostructures	Fundamental knowledge and interdisciplinary approach in Physics.
1.2	Recognize the Free electrons and Plasmonic effect, luminescence centers of some metallic dopants in semiconductors	
2	**Skills :**	
2.1	Analyze the optical properties of new emerging semiconductors.	Apply the theory and experimental concepts of Physics.
2.2	Use optical absorption and luminescence techniques identify the behaviors of dopants and defects in semiconductor's nanostructures	
3	**Competence:**	
3.1	Work effectively in groups as well as individuals.	Work effectively in groups as well as individually
3.2	Present a short report in a written form and orally using appropriate scientific language.	
3.3	Use information technology and modern computer tools to locate and retrieve scientific information relevant to electrodynamics	Use the appropriate tools and requisite media literacy to acquire, assess, and analyze data and

CLOs		Aligned-PLOs
		information from diverse sources
3...		

Course Content

No	List of Topics	Contact Hours
1	Introduction to optical materials and characteristic of optical physics in solid states	6
2	Excitons: Weekly bound excitons, tightly bound excitons, excitons in molecular crystals and in nanostructures	3
3	Optical absorption in semiconductor nanostructures, luminescence in semiconductors nanostructures	3
4	Optical behaviors of dopants and defects in semiconductor's nanostructures	6
5	Quantum confinement effect in nanostructures, Free electrons and Plasmonic effect, luminescence centers of some metallic dopants in semiconductors	9
6	Nonlinear optical semiconductors	9
7	Review	3
	Total	45

Student grievance procedures and the mechanism used:

• The student has the right to apply for re-correction of his answer papers within fifteen days from the date of announcing the result of the final exam in question. The request is submitted to the department that teaches the course, and his request is entered into the academic system and a notification is given to him.

• It is stipulated that the student should not have previously submitted three requests to re-mark final exam answer papers for courses he had previously studied, and in which final decisions were issued for rejection or preservation.

• The department head must request a statement from the course instructor, and if the correction is correct, the department head must inform the student of his answer sheet and compare it with the standard answer for the test. When the student is convinced of the correctness of the correction, he signs his request with a waiver, and the department head signs the request, considering this request One of the requests referred to in the second paragraph, provided that these procedures are completed within five working days.

• If the student is not convinced of the correctness of the correction, the department head must form a committee of two faculty members in the department, not including the course instructor, and submit its report to the department head to take his decision to amend the student's grade or reject the application, and the student is informed of the decision.

• If the department head is the course instructor, the Vice Dean for Academic Affairs will follow the previous procedures.

• If the student does not accept the decision, the student may appeal to the College Council against this decision within fifteen days from the date of being notified of it. The appeal is officially submitted to the Dean of the College, including the reasons and justifications for its submission. A form is prepared that includes the following data:

1. Student's name

2. His university number

3. Course number, code, and name

4. Class No., Semester

5. GPA

6. Absence rate

7. Number of alarms

8. Name of the course instructor

9. Test date

10. Justifications for requesting a re-correction

11. An undertaking from the student that the information provided by him is correct

12. A statement from the Deanship of Admission and Registration of the requests for re-correction previously submitted by the student, if any, and the decisions taken therein

• This form shall be submitted, together with everything related to the grievance, to the College Council in its first session after submitting the grievance. The college council, if it is not convinced of the seriousness and adequacy of the reasons for the grievance, may issue a reasoned decision to save it. If it agrees to re-correction, it forms a committee of at least three faculty members, one of whom is from outside the department and not among the course instructor, to re-correct the answer sheet.

Actions taken

• The student who has an objection to the final test score submits a request to re-correct his answer papers within fifteen days from the date of announcing the result of the final test in question. The request is submitted to the department that teaches the course, and his request is entered into the academic system and a notification is given to him.

• The head of the department informs the student of his answer sheet and compares it with the standard answer for the test. When the student is convinced of the correctness of the correction, he signs his request to waive, and the request is saved after the department head signs it, considering this request as one of the requests referred to in the second paragraph of the executive rule.

• If the student is not convinced of the correctness of the correction, the department head forms a committee of two faculty members in the department, not including the course instructor, and submits its report to the department head for his decision to amend the student's grade or reject the request, and the student is informed of the decision.

• In the event the student is not convinced, the student may appeal to the College Council against this decision within fifteen days from the date of being notified of it. The appeal is formally submitted to the Dean of the College, including the reasons and justifications for its submission, and a pledge from the student that the information he provided is correct, a statement from the Deanship of Admission and Registration with requests for re-correction previously submitted from the student, if any, and the decisions taken therein.

• If the College Council is not convinced of the seriousness and adequacy of the reasons for the grievance, it issues a reasoned decision to save it.

• If the College Council approves the re-correction, a committee is formed of at least three faculty members, one of whom is from outside the department and not among them is the course teacher to re-correct the answer sheet. It is decided upon in the first following session, and the council's decision is final by approving the minutes of the session.

Remark

It is stipulated that the student should not have previously submitted three requests to re-mark final exam answer papers for courses he had previously studied, and in which final decisions were issued for rejection or preservation.

If the head of the department is the course instructor, the Vice Dean for Academic Affairs will follow the previous procedures.