2020-2021

Laboratory Handbook

قسم الفيزياء
Physics Department
Jazan University

JAZAN UNIVERSITY

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Faculty of Science

Physics Department

1-Introduction

Physics is an experimental science and the history of science reveals the fact that most of the notable discoveries in science have been made in the laboratories. Seeing experiments being performed, i.e., demonstration experiments are important for understanding the principles of science. However, performing experiments by one's own hands is far more important because it involves learning by doing.

In Physics, an experiment is an empirical procedure that arbitrates between competing models or hypotheses. Researchers also use experimentation to test existing theories or new hypotheses to support or disprove them. Experiments form the foundation of the growth and development of science.

A general scheme of scientific investigation known as the Scientific Method involves the following steps:

1- Observations: Qualitative information about a phenomenon collected by unaided senses.

2- Experimentation: Quantitative measurements (with the help of instruments) of certain physical quantities which have some bearing on the phenomenon.

3- Formulation of hypothesis: Analysis of the data to determine how various measured quantities affect the phenomenon and to establish a relationship between them, graphically or otherwise.

4- Verification: The hypothesis is verified by applying it to other allied phenomena.

5- Predictions of new phenomena.

6- New experiments to test the predictions.

7- Modification of the law if necessary

2-Teaching Lab Policies

The objective of the laboratory sessions is to complete the physical knowledge of the students by giving him an insight into the significance of the physical ideas through the manipulation of apparatus,

Each experiment is designed to teach or reinforce an important law of physics which, in most cases, has already been introduced in the lecture and textbook. There is always a connection! If you apply the analysis tools you have learned in lecture and homework, the experiments will usually become clear and your understanding of the physics will be strengthened.

Thus the students are expected to be acquainted with the basic ideas and terminology of an experiment before coming to the laboratory.

a) Attendance

- Attendance is required at all labs without exception. If you miss a lab, you will receive a zero for your class work unless you bring a valid excuse.
- If a student knows that they will miss a lab in advance, they should communicate the reason to the lab instructor as soon as possible.
- If the lab will be missed for a valid university excuse, the student may be allowed to attend another section to makeup the lab by making arrangements with the Lab instructor.
- Tardiness will not be tolerated. Coming late to lab can expect deductions from their grades. A student who is more than 15 minutes late may be denied to access to the lab.
- Students who finish the semester with two or more unfinished labs will receive a “0” for the laboratory portion of the course.

b) Grades

- The lab grade is 20% of your grade for 2 credits course and 25% of your grade for 3 credits course.

c) **Late Work**

- Lab reports are due a week after they are assigned, at the beginning of the lab session. Any work submitted late will receive only 50% of the full marks. If you are not in class that day, you will receive a zero for that work.

d) **Good Experiments strategy**

- Come prepared and ready to participate constructively as part of your lab team!
- Set up the apparatus and check that it is working as expected.
- Take a definitive set of data and analyze it for the results and for the random uncertainties.
- Write your own experiment report. Experiment reports will be completed in the lab.

e) **The lab is a place of work**

- Do not sit idle and expect others to provide you with their data, each member of the team must become familiar with the equipment and perform some of the readings.
- All measurements are to be made by more than one student. This is a very effective way to verify a measurement.
- Do your own calculations. There is sufficient time during the lab for this to be accomplished.
- Every student has to submit your own set of graphs. The Discussion section of the lab report is not to be a collaborative effort.

Committee of Physics Laboratories

The above discussion shows the importance of laboratory work and that the experimentation is vital to the development of any kind of science and more so to that of Physics.

Physics Department, at Faculty of Science, includes 13 laboratories for undergraduate students in different fields of pure, computer science, design and medical physics.

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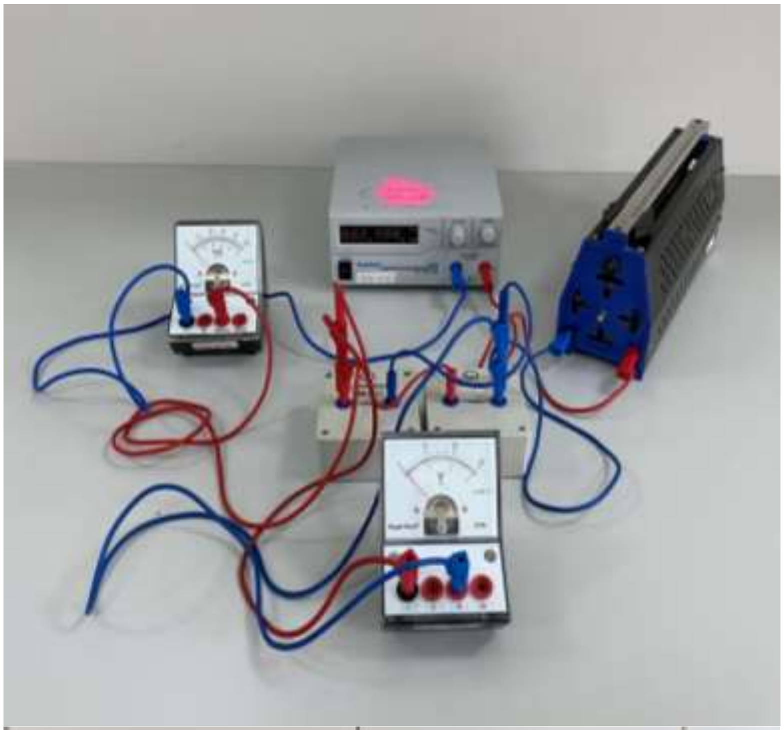
General Physics Laboratory

The General Physics Laboratory is designed to give students backgrounds in experimental techniques and to reinforce instruction in physical principles in the companion courses. These techniques and principles are quite general and applicable to aspects of all sciences.

The main objectives of the lab are:

- ✓ To offer the student experience in carrying out - and making a written description of - quantitative physical experiments, with due recognition of systematic and random errors.
- ✓ To familiarize the student with some basic lab instruments that is commonly used in making physical measurements.
- ✓ To illustrate how some basic physical principles can be applied to specific real situations in the lab.

Practical Lessons at the Laboratory of General physics (101 PHYS)	
1	Introduction
2	Accurate measurements
3	Composition of Forces
4	Force and Acceleration –Newton's second law.
5	Projectile Motion
6	Centripetal force experiment.
7	Determination of acceleration of gravity by Hooks Law and Simple Pendulum.
8	Density of water using Archimedes' Principle.
9	Surface tension of water by using metallic ring and capillary tube.
10	Viscosity of a liquid
11	Ohm's Law
12	Velocity of Sound in Air.



General Physics Laboratory (Design and Architecture)

This laboratory is an introductory course for the fundamental principles of physics. The student will be studying the main concepts of: Mechanics, dynamics, gravitation, energy, momentum, and fluid dynamics.

The experiments in the Lab include:

Practical Lessons at the Laboratory of General physics (101 PHYS)	
1	Introduction
2	Newton’s 2nd law
3	The Simple Pendulum
4	Hooks law
5	Composition of Forces
6	Projectile Motion
7	Accurate measurements
8	Archimedes' Principle
9	Viscosity of Glycerin
10	Surface tension of water
11	Ohm's Law
12	Speed of sound in air
13	Centripetal Force

Principles of Physics Laboratory (computer science)

This laboratory is an introductory course for the fundamental principles of physics. The student will be studying the main concepts of: Mechanics, dynamics, gravitation, momentum, fluid dynamics and optics.

The experiments in the Lab include:

Practical Lessons at the Laboratory of Principles of physics (201 PHYS)	
1	Introduction
2	The simple Pendulum
3	Hook's Law
4	Accurate measurements part 2- Viscosity of Glycerin
5	Surface tension of Water
6	Accurate measurements part 1- Archimedes' principle
7	Speed of sound in Air
8	Ohm's law
9	Verification of Snell's law of refraction
10	Verification of the general law of thin lenses in air
11	Magnetic force acting on a current carrying conductor

Physics for Health Specialties

This laboratory is an introductory course for the fundamental principles of physics. The student will be studying the main concepts of: Mechanics, dynamics, gravitation, momentum, fluid dynamics, electricity and optics.

The experiments in the Lab include:

Practical Lessons at the Laboratory of Physics for Health Specialties (105 PHYS)	
1	Introduction
2	Accurate measurements
3	Simple Pendulum
4	Ohm’s Law
5	Archimedes’ Principle
6	Speed of Sound in the Air
7	Viscosity
8	Concave mirror
9	Convex Lens
10	Verification of Snell’s Law
11	Surface Tension
12	Charging/Dis-Charging of the Capacitor

Properties of matter and heat Laboratory

Studying the mechanical and thermal properties of matter is fundamental in physics. The basic interrelations between such properties of solids and liquids are highly important to understand their behavior. As the material possesses a reaction due to an applied mechanical stress such as compression/elongation, shear and volume stresses, it also shows elongation, area and volume expansion due to temperature and therefore thermal energy increase. In this lab, several experiments based on Hooke's law, elasticity, thermal conductivity, and thermal expansion of solids are given. In addition to that, the kinetic theory of gases and the basic physics of the ideal gas is one of the topics covered by this lab, for example Boyle's law experiment. Finally, heat is one of the principal topics of this lab; therefore the specific heat of solids and the electrical equivalence of heat are given.

The experiments in the Lab include:

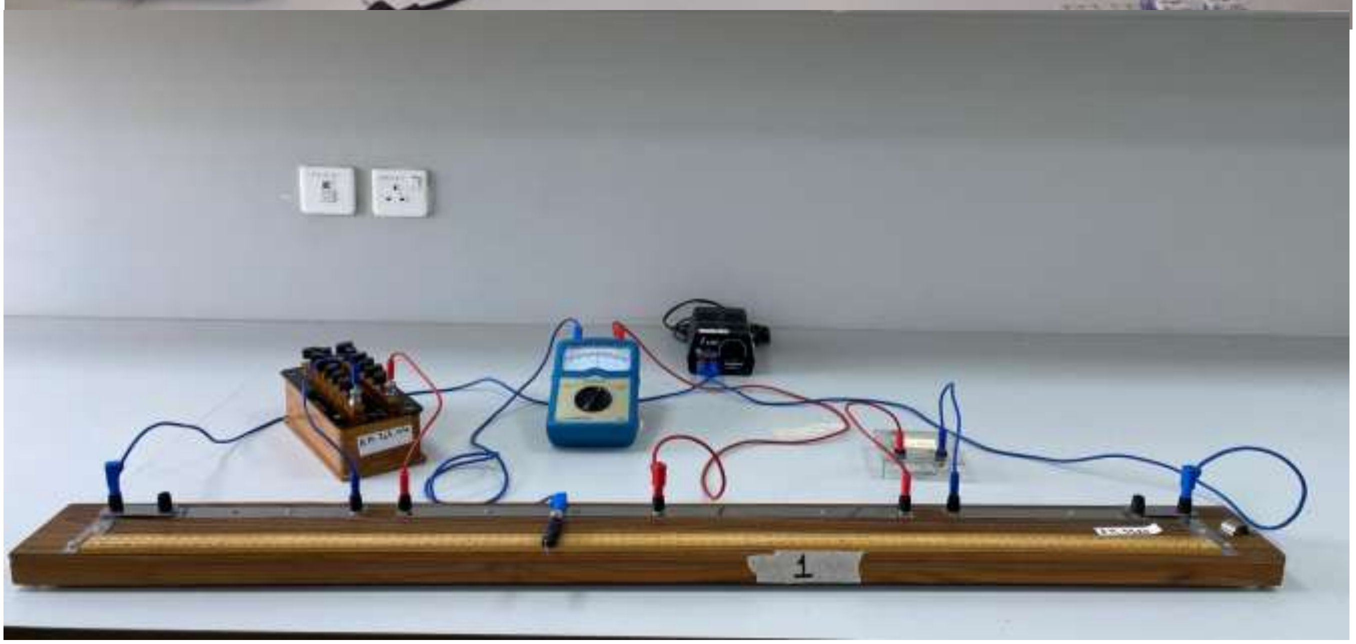
Practical Lessons at the Laboratory of Properties of matter and heat (221PHYS)	
1	Introduction
2	Determination of the torsion constant of a torsion axle
3	Determination of the moment of inertia of bodies using torsion axle
4	Determination of the acceleration due to gravity using the compound pendulum
5	Determination of Young's modulus for a wire
6	Determination of the speed of sound in Liquids
7	Verification of Boyle's law
8	Determination of the thermal conductivity coefficient for a solid
9	Determination of the linear thermal expansion coefficient of a Solid
10	Determination of the specific heat of a solid by the method of mixtures
11	Determination of the electrical equivalent of heat

Electricity and Magnetism Laboratory

The objective of this course is to teach electricity and magnetism (E&M) by observations from experiments. This laboratory experience is designed to guide your learning of fundamental concepts of experimentation and data collection, delivered through the medium of hands-on experiments in electricity and magnetism. As a student, you should be aware that you and your colleagues will have a broad set of backgrounds in math, science, and writing and a similarly broad set of career trajectories. It includes the basic experiments related to the subject of static electricity and electric current.

The experiments in the Lab include:

Practical Lessons at the Laboratory of Electricity and Magnetism (231PHYS)	
1	Introduction
2	Determination of the specific resistance of a wire using Meter Bridge.
3	Determination of the specific resistance of a conducting wire using Ohm's law
4	Determination of the internal resistance of a battery using potentiometer.
5	Determination of the internal resistance of a voltmeter
6	Determination of a low resistance using a standard resistance
7	Determination of the capacitance of unknown capacitors by discharging method
8	Capacitance of capacitors in series and parallel combinations
9	Magnetic force acting on a current carrying conductor
10	Magnetic field of a current carrying solenoid.
11	Determination the horizontal component of earth’s magnetic field using tangent galvanometer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Geometrical Optics Laboratory

Optics is the study of the way light interacts with other objects. This behavior can be extremely complicated. However, if the objects in question are much larger than the wavelength of the light being studied, then the light exhibits much simpler behavior. This behavior is described by the laws of geometric optics. In geometric optics light is assumed to move only in straight lines, except where it meets barriers. At different barriers, light rays are reflected or refracted based on the material properties of the barrier. The angle at which this reflection or refraction occurs is determined by the law of reflection and Snell's law respectively. In this lab, you will use the technique of ray tracing to verify both the law of reflection and Snell's law. You will then use this same technique to study the properties of lenses (which make use of refraction to focus or defocus light). Finally, you will apply your understanding of lenses to design a small telescope.

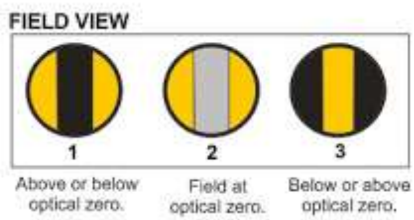
The experiments include:

Practical Lessons at the Laboratory of Geometrical Optics (211 PHYS)	
1	Introduction
2	Color Addition
3	Snell's Law (by trapezoid)
4	Refractive Index and Critical angle of Glass
5	Convex mirror
6	Concave mirror
7	The focal Length for a convex lens
8	The Focal Length for a Concave Lens
9	The equivalent focal length of two convex lenses
10	The refractive index of a prism using the spectrometer
11	Microscope.

Physical Optics Laboratory

This is an experimental class dedicated to introduce the physics of optics. We will perform experiments on interference, diffraction, polarization, and coherence properties of waves with emphasis on light. We use statistical methods to analyze and interpret our experimental data. To introduce the main concepts and experimental methods in optical physics. We emphasize the physical principles involved in the experiments and the basic physical phenomena. All experiments are quantitative and usually involve observations, measurements, data analysis and interpretation. The experiments include:

Practical Lessons at the Laboratory of Physical Optics (312 PHYS)	
1	Introduction
2	Interference of light using Young's double-slit
3	Diffraction of light through a single-slit
4	Diffraction grating spectrometer
5	Diameter of a Human Hair by Laser Diffraction
6	Michelson interferometer
7	Newton's interference rings
8	Malus' law of polarization
9	Optical activity and polarization
10	Brewster's angle
11	Kerr effect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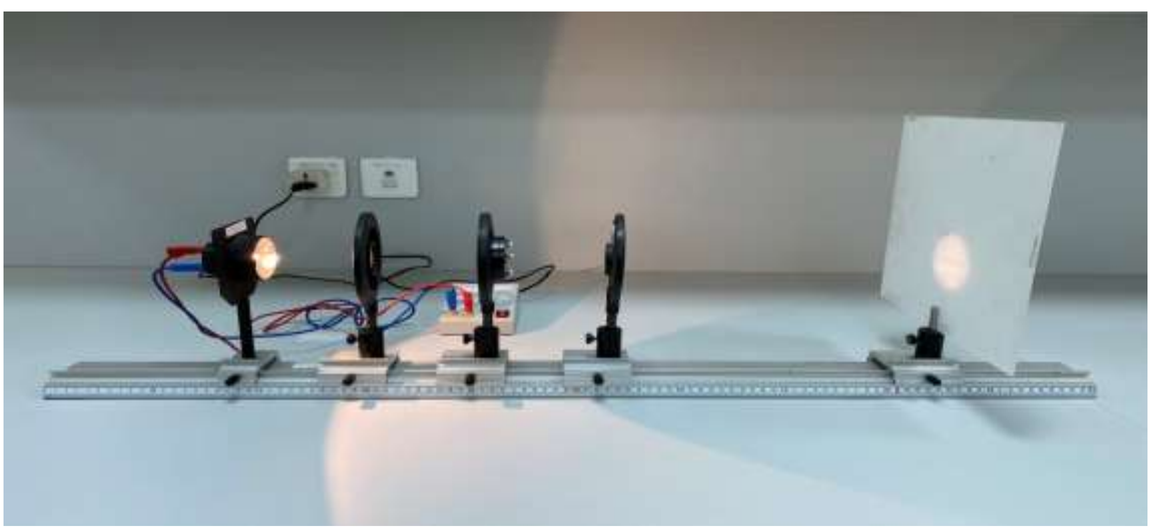
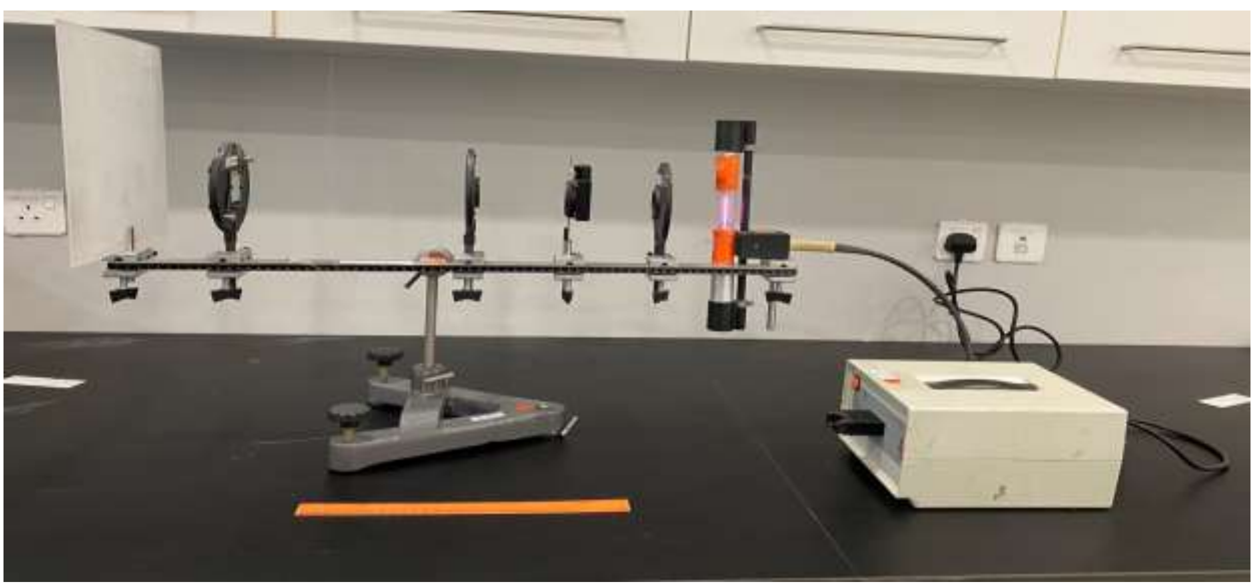


Atomic Physics and Spectroscopy Laboratory

Atomic physics is the field of physics that studies atoms as an isolated system of electrons and an atomic nucleus. It is primarily concerned with the arrangement of electrons around the nucleus and the processes by which these arrangements change. The term "spectroscopy" defines a large number of techniques that use radiation to obtain information on the structure and properties of matter. In this lab you will perform the experiment which helps to investigate the concept of quantization of energy levels according to Bohr’s model, measure the discontinuous energy emission of free electrons for inelastic collision, and interpret the measurement results as representing discrete energy absorption by mercury atoms.

The experiments include are:

Practical Lessons at the Laboratory of Atomic Physics and Spectroscopy (342 PHYS)	
1	Introduction
2	Determination of wavelengths of Hα, Hβ and Hγ from the Balmer series of hydrogen
3	Determination of wavelengths of Hα, Hβ and Hγ from the Balmer series of hydrogen using grating spectrometer
4	Determination of wavelengths of Mercury spectral lines
5	Determination of wavelengths of mercury spectral lines using grating spectrometer
6	Determination of fine structure, one-electron spectra, using diffraction grating
7	Franck-Hertz Experiment
8	Bragg reflection: diffraction of x-rays at a mono-crystal
9	The Zeeman Effect
10	Determination of wavelengths of Mercury using a CCD sensor

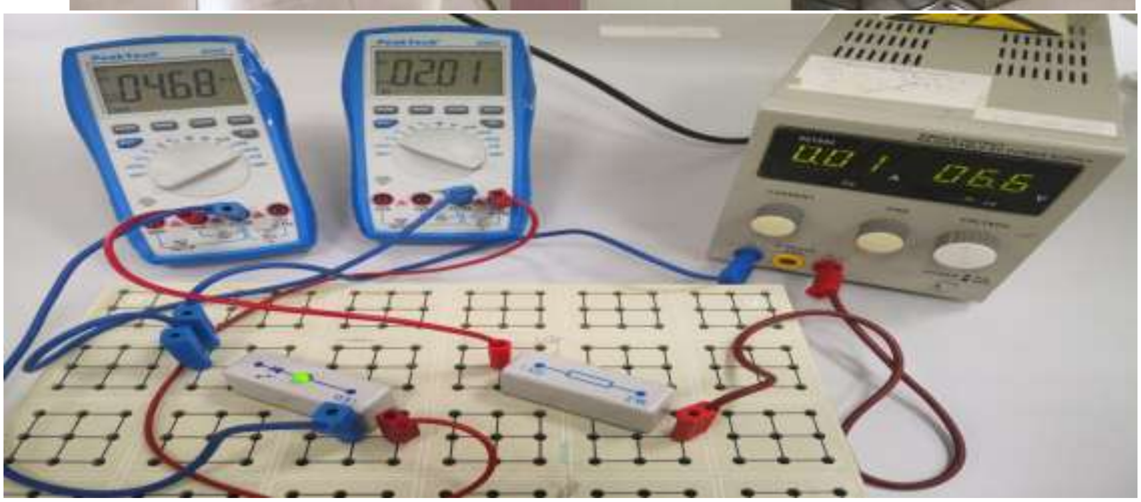


Electronics Laboratory

Electronics Lab focuses on studying different electrical circuits, how they work and how they are connected. As well as to draw the relationship between the difference of voltage and electric current graphically with the analysis of the drawing and conducting mathematical calculations. The practical course can be divided into four concepts. The first is the alternating current and the electrical signal form of the AC source coming into electronic circuits consisting of a coil, capacitor and resistor. The second concept is diode in several types, such as normal diode, light-emitting diode and Zener diode. The third concept is the transistor BJT and JFET. Finally, the concept of simple and complex logic gates.

The experiments include are:

Practical Lessons at the Laboratory of Electronics (411 PHYS)	
1	Introduction
2	Cathode ray oscilloscope measurements of D.C voltage, A.C voltage and frequency
3	R,L,C and R.C A.C. circuits and applications
4	Series resonance circuits and applications.
5	Forward and reverse characteristics of PN junction diodes
6	Light emitting diodes characteristics.
7	Half-wave and full wave rectification
8	Zener diode characteristics and applications as voltage regulator.
9	Bipolar junction transistor characteristics (BJT)
10	Junction field effect transistors (JFET) characteristics
11	Operation amplifier circuits
12	Logic gates and applications

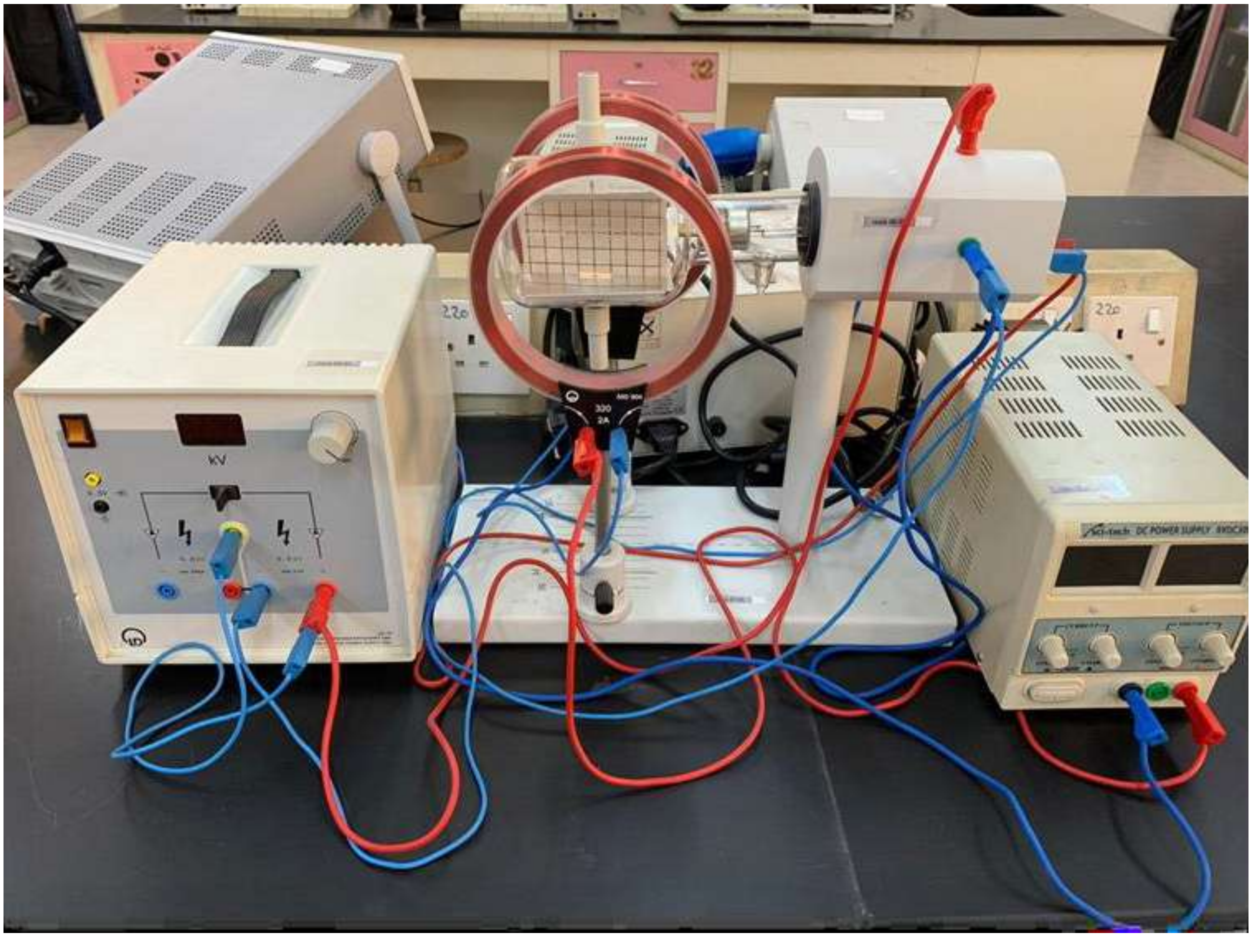


Modern Physics Laboratory

Modern Physics is a laboratory course focusing on important experiments in modern physics. The lab is really a sequence of experiments designed to study the properties of electrons, photons atoms and their interactions. It is the hope that these experiments will enhance your classroom learning about modern physics and quantum mechanics. During this course, you will have the opportunity to: (i) repeat some very important experiments and gain experience with a variety of experimental techniques. (ii) analyze and synthesize non-trivial experimental data.

The experiments included are:

Practical Lessons at the Laboratory of Modern Physics (441 PHYS)	
1	Introduction
2	Millikan's Experiment
3	Determination of the specific Charge of the Electron (e/m) by the Deflection of Electrons in Thomson Tube
4	Determination of (e/m) from the full circular path of the electron moving in magnetic field
5	Photoelectric Effect
6	Investigating the energy spectrum of an X-ray tube as a function of the high voltage
7	Investigating the energy spectrum of an X-ray tube as a function of the emission current
8	Duane-Hunt relation and determination of Planck's Constant
9	Rutherford Scattering: measuring the scattering rate as a function of the scattering angle and the atomic number
10	Fine structure of the characteristic X-radiation of a molybdenum anode
11	Compton Effect: verifying the energy loss of the scattered X-ray quantum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Nuclear Physics Laboratory

Nuclear physics studies the structure of nuclei—their formation, stability, and decay. It aims to understand the fundamental nuclear forces in nature, their symmetries, and the resulting complex interactions between protons and neutrons in nuclei and among quarks inside hadrons, including the proton.

The experiments of Nuclear physics in the laboratory reviews the physics of nuclear reactions and the interaction of radiation with matter, calculating half-life of radioactive isotopes and then discusses alpha, beta and gamma ray spectrometers as well as calibration and efficiency of radiation detectors.

The experiments included are:

Practical Lessons at the Laboratory of Nuclear Physics (462 PHYS)	
1	Introduction
2	Plotting of Geiger Muller plateau
3	Geiger tube efficiency
4	Inverse square law
5	Absorption of gamma radiation
6	Back scattering of gamma rays
7	Determining the half-life of Ba -137m
8	Recording and calibrating gamma spectrum
9	Detecting efficiency of sodium iodide (thallium) detector
10	Calculation of beta/gamma ratio


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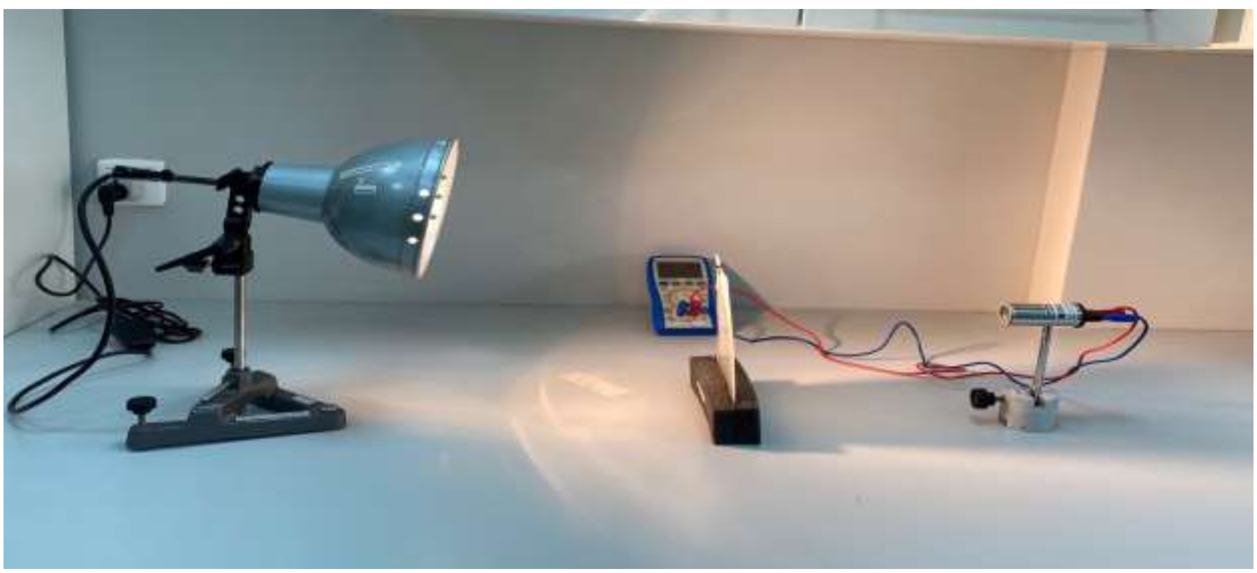
Solid state Physics Laboratory

Solid-state physics is the largest branch of condensed matter physics. It is the study of rigid matter, or solids, through methods such as quantum mechanics, crystallography, electromagnetism, and metallurgy. It comprises main experiments involving some solid materials and studying their crystalline composition and the study of their electrical and thermal properties. The experiments included in this lab are:

Practical Lessons at the Laboratory of Solid State Physics (471 PHYS)	
1	Introduction
2	Determination of Seebeck coefficients of thermocouples
3	Linear absorption coefficient of dielectric material
4	Luminescence: Fluorescence of a luminescent screen due to x-rays
5	Solar cell characteristics
6	Detection of X-rays using ionization chamber
7	Carrier concentration of metal using Hall Effect
8	Electrical characteristics of semiconductor photo-resistor
9	Planck constant using light emitting diodes
10	Energy gap of Si using PN junction
11	Determination of Boltzmann Constant
12	The ferro-magnetism




Lab
Safety

Safety Rules for Physics Laboratories

We recommend that students working in Physics research labs follow the safety guidelines below:

- All liquids used in the fluid mechanics lab must be stored in labeled containers.
- All electrical supplies must be safely put away after use.
- Any liquid (safe liquid) spills must be cleaned up immediately to avoid injuries. In case of bigger leaks, the appropriate authorities (the primary faculty in charge or other department faculty/staff) must be notified.
- All glassware must be handled carefully and stored in its appropriate place after use.
- Equipment cannot be removed from labs for any reason without prior permission from the faculty in charge.
- Please exercise caution when handling liquids in the vicinity of electrical equipment.

Safety Guidelines for Radioactive Lab

All purchase orders of radioactive materials that are in routine use and authorized by the Jazan Univesity are done by the department administrators. When filling the order please note to give the correct and full information:

- Catalogue (code) number
- Radioisotope (i.e. P-32)
- Quantity
- Activity (in milli Curie only)
- Full name of authorized user
- Building and room number of the laboratory where the radioisotope will be used
- Phone number of the laboratory

Safety Guidelines for Radioactive Lab Work

- Understand the nature of the hazard and get practical training. Never work with unprotected cuts or breaks in the skin, particularly on the hands or forearms. Never use any mouth operated equipment in any area where radioactive material is used. Always store compounds under the conditions recommended. Label all containers clearly indicating nuclide, compound, specific activity, total activity, date and name of user. Containers should be properly sealed.

- Plan ahead to minimize time spent handling radioactivity. Carry out a dummy run without radioactivity to check your procedures. The shorter the time the smaller the dose.
- Distance yourself appropriately from sources of radiation. Doubling the distance from the source quarters the radiation dose (Inverse Square Law).
- Use appropriate shielding for the radiation 1 cm Perspex will stop all beta particles but beware "Bremsstrahlung" from high energy beta emitters. Use lead acrylic or a suitable thickness of lead for X and gamma emitters.
- Contain radioactive materials in defined work areas Always keep active and inactive work separated as far as possible, preferably maintaining rooms used solely for radioactive work. Always work over a spill tray and work in a ventilated enclosure. These rules may be relaxed for small (a few tens of kBq) quantities of H-3, S-35, C-14 and I-125 compounds in a non-volatile form in solution.
- Wear appropriate protective clothing. Laboratory coats, safety glasses and latex gloves must be worn at all times. Beware of static charge on gloves when handling fine powders. Local rules will define what dosimeters should be worn for work with high-energy isotopes.
- Monitor the work area frequently for contamination control in the event of a spill follow the prepared contingency plan:

- Verbally warn all people in the vicinity
- Restrict unnecessary movement into and through the area
- Report the spill to Radiation Safety
- Treat contaminated personnel first
- Follow clean-up protocol

- Follow the local rules and safe ways of working. Do not eat, drink, smoke or apply cosmetics in an area where radioactive substances are handled. Use paper handkerchiefs and dispose of them appropriately. Never pipette radioactive solution by mouth. Always work carefully and tidily.

- Minimize accumulation of waste and dispose of it by appropriate routes. Use the minimum quantity of radioactivity needed for the investigation. Disposal of all radioactive waste is subject to statutory control. Be aware of the requirements and use only authorized routes of disposal.
- After completion of work – monitor yourself, wash and monitor again never forget to do this. Report to the local supervisor if contamination is found.

Lab Committee