Al-Karkh University of Science

First Cycle – Bachelor's Degree (B.Sc.) – Medical Physics

بكالوريوس – الفيزياء الطبية

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1. Overview

This catalogue is about the courses (modules) given by the program of Medical Physics to gain the Bachelor of Science degree. The program delivers (49) Modules with (6000) total student workload hours and 240 total ECTS. The module delivery is based on the Bologna Process.

نظره عامه

يتناول هذا الدليل المواد الدراسية التي يقدمها برنامج الفيزياؤ الطبية للحصول على درجة بكالوريوس العلوم الفيزياء الطبية . يقدم البرنامج (49) مادة دراسية، على سبيل المثال، مع (٦٠٠٠) إجمالي ساعات حمل الطالب و ٢٤٠ إجمالي وحدات أوروبية. يعتمد تقديم المواد الدراسية على عملية بولونيا.

2. Undergraduate Courses 2023-2024

Module 1

Code	Course/Module Title	ECTS	Semester
KUS11001	Academic Mathematic	5	1
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62
Description			

- Following up the scientific development of mathematics by reviewing modern curricula.
- Follow-up and development of academic courses and compare them with other universities.
- Using the latest teaching aids to motivate the student to learn and understand.

Module Learning Outcomes

1. Recognize properties of functions and their inverses;
2. Recall and use properties of polynomials, rational functions, exponential, logarithmic, trigonometric and inverse-trigonometric functions;
3. Apply the differentiation procedures to solve related rates and extreme value problems;

4. To understand the term integration.

5. To distinguish between definite and indefinite integration.

6. To describe the area and volume by means of integration.

Module Aims:

1.Identify the properties of mathematical functions and their opposites.

2. Familiarity with the properties of polynomials, exponential and logarithmic functions trigonometric functions and their opposites.

3. Recognize the concept of differential functions and its relationship to speed and the rate of their change with time (acceleration).

4. Identify the integration of the functions and methods of Integration.

5. Knowledge of applications of integral in geometry.

Module 2

Code	Course/Module Title	ECTS	Semester
KUS11002	Fundamental of computer science	3	1
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
1	2	48	27
Description			

When it comes to teaching computer programming, it is important to use strategies that engage students, promote active learning, and facilitate the development of problem-solving and critical-thinking skills. Here are some effective teaching strategies for computer programming:

1. Hands-on coding practice: must provide ample opportunities for students to write code and practice programming through assign coding exercises, projects, and challenges that allow students to apply the concepts they have learned.

2. Pair programming: should encourage students to work in pairs, with one student as the "driver" who writes the code and the other as the "navigator" who reviews the code and offers suggestions. This collaborative approach promotes active learning, communication, and problem-solving skills.

3. Code reviews and feedback: Regularly review and provide feedback on students' code. Offer constructive criticism and guidance on how to improve their programming skills. Encourage students to review and provide feedback
to their peers, fostering a culture of collaboration and continuous improvement.

Module Learning Outcomes

1. Recognize properties of functions and their inverses;

2. Recall and use properties of polynomials, rational functions, exponential, logarithmic, trigonometric and inverse-trigonometric functions;

3. Apply the differentiation procedures to solve related rates and extreme value problems;
4. To understand the term integration.
5. To distinguish between definite and indefinite integration.
6. To describe the area and volume by means of integration.

Module Aims:

1.This course provides a manual to operate MATLAB. It presents a detailed course of MATLAB code capabilities required for general programming.

2. MATLAB is a high-performance language of technical computing. It integrates calculation, visualization and programming in an easy-to-use environment where problems and solutions are expressed in writing programs and implementing algorithms through the graphical user interface. MATLAB is an interactive system whose basic data element is an arrays that does not require dimensions. This allows solving many technical computing problems, especially those with matrix and vector formulations.

3. This course includes interactive lectures and practical applications to enable the student to apply algorithms for image processing and apply enhancement methods. In addition, it enables the student to rotate and scale the image by applying many examples.

Module 3

Code	Course/Module Title	ECTS	Semester
KUS11003	Democracy and Human Rights	2	1
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	17
Description			

نعمد في هذا الجانب إلى ما يلي:

١. يعرف الطالب إبتداءً بمضمون موجز عن المفردات التي سيتم تناولها خلال المحاضرة، ثم نوجه له بعض الإسئلة التي تحرك ذهنه، وتشد إنتباهه؛ لضمان حسن الاستماع.

٢. يتم التعمق بشرح المفردات العلمية في حدود تناسب متوسط المستويات العلمية لضمان عدم تجاوز الفروق الفردية عند عموم الطلبة.

٣. يتم ترك مساحة للنقاش الحر في إطار الموضوع المخصص للمحاضرة.

٤. الحرص على جانب التغذية الراجعة للمعلومات قبل نهاية المحاضرة.

٥. التواصل الكترونيًا مع الطلبة لنشر المحاضرات المسجلة، والمكتوبة من خلال الموقع الرسمي للجامعة.

Module Aims

تهدف المادة الى بيان اهمية الحقوق الاصلية اللصيقة بالانسان، التى تتفق مع فطرته والتى يقبلها العقل المجرد، والتي لا تختلف باختلاف الزمان والمكان وهذه هي حقوق الانسان

Module Learning Outcomes:

تسهم المادة العلمية الى تثقيف الطالب من الناحية القانونية، ليكون مطلع على ماهية الحقوق الانسانية واصلها التاريخي وتعريف ماله من حقوق وماعليه من التزامات من خلال معرفة حقه وحدود ذلك الحق وحقوق الاخرين، وما سعت اليه الدول والمنظمات الدولية والاقليمية في تعزيز مفاهيم تلك الحقوق، والزام الدول للنص عليها في التشريعات الداخلية والضمانات التي تكفل تطبيق تلك الحقوق العالمية.

Module 4

Code	Course/Module Title	ECTS	Semester
SCI11004	General Biology	7	1
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97
Description			

Many strategies will be used in this module to encourage students to learn such as participation in the exercises, seminars, lab experiments, and workshops, as well as using educational videos and electronic to refine and expand their critical thinking skills. This will be achieved through classes, interactive tutorials, and by considering types of simple experiments involving some interesting sampling activities for the students.

Module Learning Outcomes

1. Identify the most important differences between animals, plants, and microorganisms
2. Identify the processes of evolution in the organisms and the theories of their emergence
3. Statement the divisions of the plant kingdom and the animal kingdom
4. Identify the types of animal and plant tissues
5. Identifying the interdependent relationship between animals and plants.

Module Aims

1. Give a general understanding of the types, divisions, and components of organisms.
2. Understand the effect of organisms on humans and their environments.
3. Gain practical knowledge of the classification of organisms
4. Complete the reports, seminars, and presentations to develop the student's skills.

Module 5

Code	Course/Module Title	ECTS	Semester
SCI11005	General Chemistry	7	1
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

To describe the learning activities of the students and the teaching methods of the staff. Effective module design should result in a varied range of active learning experiences for students, including learning activities which are 'research-like'.

Activities should, of course, motivate and encourage deep learning (reflection on wider meanings, rather than superficial memorisation of information). They should also be varied and flexible enough to accommodate different learning styles and orientations, and allow for inclusivity of students from different backgrounds and with different kinds of learning abilities.

Learning activities therefore need to include reference to independent, interdependent (peer- supported) and online activities, as well as participation in different kinds of taught class.

Module Learning Outcomes

1. Recognize the classification of elements.
2. List the various terms associated with periodic table.
3. Summarize what is meant by a basic chemical property.
4. Discuss the reaction and involvement of atoms in chemical reaction.
5. Describe bonds, oxidation number, and Lewis term.
6. Identify the elements according to conductivity and their applications.
7. Discuss the electrons distribution in the atomic levels.

Identify the primary terms that used to characterize physical and chemical properties.

Module Aims

1-To develop skills and understanding of different types of elements through the application of techniques.

2. To understand metals, physical and chemical properties.

3. This course deals with the basic concept of general chemistry. To understand periodic table and distribution elements on it

Module 6

Code	Course/Module Title	ECTS	Semester
MPH11006	Electricity	6	1
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	87

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students. And online activities, as well as participation in different kinds of taught class.

Module Learning Outcomes

1. Differentiate between conductors and insulators;
2. Explain charging processes.
3. State, derive and use Coulomb's law to solve problems about electric field and electric potential.
4. Use Gauss' law to a number of kinds of charge distributions in space having high symmetry (spherical, cylindrical, and uniform-plane distribution).
5. Derive the expression for calculating capacitance.
6. Explain the physical basis of Ohm's law and use Ohm's law in solving various problem of resistors connected in parallel and in series.problem of resistors connected in parallel and in series.

Module Aims

The study of electric charge involves differentiating between conductors and insulators and using them to demonstrate the existence of charges. In addition, Coulomb's law will be stated and its expression derived and used in calculations. Along with this, electric field, dipole moments; potential energy; and torque on an electric dipole and flux of electric field will be defined. Their expressions will be derived and also used to solve problems.

Module 7

Code	Course/Module Title	ECTS	Semester
MPH12007	Mechanics	7	2
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

This course will be delivered through a combination between theoretical lectures in the classroom and experimental lectures in the Lab. The students will receive the outcome of each lecture through discussions, videos related to the subject and questions. In addition, the information will be developed by self-learning through reading and searching to hand in the essay and home works.

Module Learning Outcomes

1. Define the meaning of mechanics.
2. Develop a clear understanding of basic physical phenomena in physics and materials science as an integral part of the student's overall education.
3. Compare between vectors and scalar quantities.
4. Calculate and find the displacement, velocity and acceleration of bodies.
5. Use algebra, trigonometry, and basic calculus, in solving problems in one and two dimension motion.
6. Provide detailed and accurate description of forces effect on bodies.
7. Classify the energy types.
8. Calculate the work done on subject.

Module Aims

1. To develop an understanding of the fundamentals of mechanics.
2. To develop problem solving skills in mechanics through the application of concepts in statics and dynamics to real world problems.
3. To introduce the standards and associated measurements that regulate the use of mechanics.
4. To provide reinforcement of learning using laboratory investigations.

Module 8

Code	Course/Module Title	ECTS	Semester
MPH12008	Magnetism	6	2

Class (hr/w)	Lect/Lab./Prac./Tutor	SSWL (hr/sem)	USWL (hr/w)
2	3	78	72

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.

Module Learning Outcomes

1. Define the terms: magnetic field, magnetic flux and flux density
2. 2. Explain and draw magnetic field lines associated with current
3. carrying conductors, and explain the principles of instruments
4. based in it;
5. Explain the principles of an oscilloscope;
6. State, explain and use Faraday's law of electromagnetic induction;
7. Derive expression for force on a current-carrying wire in a magnetic field
8. Relate the force (F) to velocity (v), charge (q) and magnetic field (B)
9. How electromotive force induced.

Module Aims

This unit is designed to provide experiences for the student that will lead him/her into an understanding of the similarities and differences among electric, magnetic, and gravitational fields. The inquiry projects used here will support instruction in electrical circuits, gravitational dynamics, and electromagnetic phenomena of all sorts. The students will know how to demonstrate magnetic field and interaction using magnets, and current-carrying wire, show the influence of the magnetic field by a moving charge using a oscilloscope, and demonstrate the electromagnetic induction/ Faraday's law using simple materials.

Module 9

Code	Course/Module Title	ECTS	Semester
MPH12009	Programming	6	2
Class(hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

When it comes to teaching computer programming, it is important to use strategies that engage students, promote active learning, and facilitate the development of problem-solving and critical-thinking skills. Here are some effective teaching strategies for computer programming:

1. Hands-on coding practice: must provide ample opportunities for students to write code and practice programming through assign coding exercises, projects, and challenges that allow students to apply the concepts they have learned.

2. Pair programming: should encourage students to work in pairs, with one student as the "driver" who writes the code and the other as the "navigator" who reviews the code and offers suggestions. This collaborative approach promotes active learning, communication, and problem-solving skills.

3. Code reviews and feedback: Regularly review and provide feedback on students' code. Offer constructive criticism and guidance on how to improve their programming skills. Encourage students to review and provide feedback to their peers, fostering a culture of collaboration and continuous improvement.

4. Project-based learning: Assign projects that require students to design and develop software applications or solve real-world problems using programming. Project-based learning provides a context for applying programming skills, encourages creativity, and promotes deeper understanding of programming concepts.

5. Demonstrate coding practices: Model good coding practices by writing clean, well-structured code. Explain the reasoning behind coding decisions, such as variable names, code organization, and documentation. Show examples of code refactoring and optimization to help students understand the importance of writing efficient code.

6. Use visual aids and interactive resources: Utilize visual aids, diagrams, flowcharts, and interactive programming environments to explain programming concepts. Visual representations can help students grasp abstract concepts and understand program flow.

Module Learning Outcomes

The learning outcomes of studying computer programing include:

1. Providing the student with cognitive skills from the basic concepts of programming language and enables them to the skills to run the MATLAB program and dealing with the MATLAB windows and all the types of Statements.
2. Enables students to understood and run all Statements (Loop, Control, Branch), reading and writing data file.
3. Providing the student with cognitive skills to deal with operations with Arrays or Matrices.

4. Providing the student with skills in the technique of dealing with ready-made functions in the language of MATLAB.
5. Providing the student with skills in the Plotting Capabilities, Subplots, 2D Plotting, 3 D Plotting
6. Enables students to deal with the Files: M-files, and functions.
7. They will also learn about algorithms and how to apply them to solve problems.
8. Additionally, they will acquire skills in opening graphical interfaces using the GUIDE UI.
9. Furthermore, the course will cover the types of images and their importance in processing.

Module Aims

1.This course provides a manual to operate MATLAB. It presents a detailed course of MATLAB code capabilities required for general programming.

2. MATLAB is a high-performance language of technical computing. It integrates calculation, visualization and programming in an easy-to-use environment where problems and solutions are expressed in writing programs and implementing algorithms through the graphical user interface. MATLAB is an interactive system whose basic data element is an arrays that does not require dimensions. This allows solving many technical computing problems, especially those with matrix and vector formulations.

3. This course includes interactive lectures and practical applications to enable the student to apply algorithms for image processing and apply enhancement methods. In addition, it enables the student to rotate and scale the image by applying many examples.

Module 10

Code	Course/Module Title	ECTS	Semester
KUS12010	Arabic Language	6	2
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	17
Description			
صناعة شخصية متكاملة للطالب الجامعي من حيث التخصص العلمي الدقيق والتخصص المساند			

Module learning Outcome

1- تعلم العربية السليمة كونها اللغة الرسمية للوطن
2- اللغة جوهر الهوية ورمزها
3- اللغة تختلف عن اللهجة، فالاولى عالمية والثانية محلية
4- توظيف المفردات الفصيحة في الصياغة الاكاديمية للبحوث العلمية مترجمة بنظيرها الفصيح
5- التمكّن من كتابة البحوث والمقالات ذات المحتوى العلمي الصرف باللغة العربية الفصحى
6- تجنب الاخطاء الشائعة في الكتابة واختيار المفردات الصائبة
7- اثراء الخزين المعجمي لدى الطالب للمساعدة في بناء كاريزما التواصل الكلامي
8- الاطلاع على نماذج من الادب العربي شعرا ونثرا لما لها من اساس في بناء الجانب الثقافي المتنوع لدى الطالب
9- كتابة الاعداد بتمكّن فضلا الكتابة الصحيحة في صياغة الطلبات الرسمية
10- التعرف على الدرس الصوتي في اللغة العربية وعلاقته بعلم الفيزياء

Module 11

Code	Course/Module Title	ECTS	Semester
KUS12011	English Language	2	2
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	71
Description			

Use will be made of individual, pair and group work to develop students' abilities to read increasingly complex academic and general texts. Other skills will be practiced and developed within this modules and students will be expected to work extensively out of class to develop their reading fluency. Students will study the specialist vocabulary in the context of published listening and reading materials produced particularly for these ESP situations and also explore lexis within authentic sources.

Groups will be managed according to specialist areas and students will be expected to work extensively outside class contact time. Emphasis will be placed on integrating this module to work done within the International Foundation option module programme

Module Learning Outcomes

1. Enhance the efficiency of student to use many reference or books which reported in English language.

2. To develop the competence that students need to read a wide range of general and academic texts in English.
3. To develop students competence in reference skills [locating and evaluating information needed for assignments in a library.
4. demonstrate adequate general and detailed comprehension of a range of advanced general and academic texts.
5. undertake research in an academic library.

Module Aims

a. To enable the learner to communicate effectively and appropriately in real life situation:

b. to use English effectively for study purpose across the curriculum;

c. to develop interest in and appreciation of Literature;

d. to develop and integrate the use of the four language skills i.e. Reading, Listening, Speaking and Writing; e.to revise and reinforce structure already learnt

Module 12

Code	Course/Module Title	ECTS	Semester
SCI12012	General Physics	7	2
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, online lectures and home works and by considering type of simple experiments involving some sampling activities that bring attention of the students.

Module Learning Outcomes

1. Save in memory basic principles and laws of Fluids and material properties.
2. Produce scientific concepts by joining between physical principles.
3. Joining physical concepts to produce more complicated concepts.
4. The ability to make conclusions by analysis the physical information.
5. The ability to apply all his knowledge to solve problems in reality.
6. To be able to run the devices and apparatus in the lab.
7. Assemble devices and make an experiment to prove physical relation.
8. Discuss the results get from running experiment in the lab.
9. Make reports from theory to conclusion about any physical concept proved in the lab.

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Module Aims

1. To have knowledge about General Physics basic principles like Mechanics of liquid and material properties.
2. To get skills in solving mathematical problems that related to physics subjects.
3. To get practical skills in managing physics experiments in the lab. and record measurements and then calculate required quantities.
4. Analysis the physical information in syllabus and be able to make conclusions by joining between physical concepts.
5. To be able to apply his knowledge in physics in market.

Module 13

Code	Course/Module Title	ECTS	Semester
KUS23016	Crimes of Baath Regime in Iraq	2	3
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	17
Description			

من خلال مقاييس اسلوب المناقشة والاختبارات اليومية

Module Learning Outcomes

1- معرفة الجرائم التي ارتكبت من قبل نظام البعث .

2- معرفة انواع الظلم والاضطهاد الذي ارتكب بحق العراقيين

Module Aims

1- ان يتعرف الطالب على جرائم نظام البعث في العراق
2- ادراك الطالب لتاريخ الحقبة التيعاشها العراق خلال فترة نظام البعث
3- ادراك الطالب لكم الجرائم النفسية والاجتماعية التي ارتكبها النظام
4- ادراك الطالب للجرائم التي ارتكبت بحق البيئة من قبل النظام

Module 14

Code	Course/Module Title	ECTS	Semester
MPH21013	Differential Equations	4	3

Class (hr/w)	Lect/Lab./Prac./Tutor	SSWL (hr/sem)	USWL (hr/w)
2	1	48	52

Description

1- Method of giving lectures, explanation and clarification.

2- Student groups.

3- E-learning within the university.

4- Application of education.

Module Learning Outcomes

1- Enabling students to obtain knowledge and understanding of the topics of differential equations.

2- Enable students to obtain knowledge and understanding of solve of method equations

3-Enable students to obtain knowledge and understanding of the use of basic physical laws in D.E and their use in solving problems.

Module Aims

1- Providing the student with a cognitive skill about the basic concepts of Derivative equations.

2- Introducing students to the most important principles of differential equations and applications.

3- Introduce the student to the differential equations and methods of their application.

4- Providing the student with knowledge of how to solve equations.

Module 15

Code	Course/Module Title	ECTS	Semester
MPH21014	Optics	7	3
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

Strategies in teaching optics are centered on the teacher and the students, It depends mainly on equipping the student with theoretical and practically skills in the field of geometric optics and wave optics through the participation of students in preparing reports, assignments, seminars and projects, preparing lectures, solve optics examples and encouraging students' teamwork. And conduct optics experiments in the laboratory and increase their scientific skills and how they deal with devices and optical elements. The

strategy of the optics class is to increase students' awareness of the importance of optical laws on which medical devices used in medical clinics and hospitals depend.

Module Learning Outcomes

1. Distinguish between the ray optics and wave optics.
2. Calculating the refractive index, the optical path and determining the critical angles for light travels between two media.
3. Knowing how to form images in lenses and mirrors, calculating the focal length of optical elements.
4. Determining vision defects and how to calculate the appropriate focal length for each pathological condition of vision defects.
5. Distinguish between interference and diffraction of light and calculation the fringes width.
6. Determine the constructive interference equation for bright fringes and the destructive interference equation for dark fringes.
7. Study the electromagnetic spectrum and determine the photon's energies.
8. Defining polarization, identifying its types, and calculating the intensity of light transmitted by polarizers.

Module Aims

1. Understand the fundamental of optics that representing by geometrical optics and waves optics.
2. Increase students' knowledge about optics terms such as refractive index, optical path, critical angle, total internal reflection, thin lenses, mirrors, and image formation by optical elements, as well as Interference phenomena, Diffraction phenomena, polarization phenomena of light.
3. Provide the student with knowledge information about the electromagnetic spectrum and its wide uses in the medical fields (medical imaging and medical treatment as well as medical devices based on light).
4. Preparing the student to deal professionally with optical devices and optical elements, and how to calculate their optical constants.
5. Enable the student to distinguish between the Interference phenomena and Diffraction phenomena.
6. Provide the student with knowledge about the most important optical element present in the human body, which is the eye, and how to determine vision defects mathematically.

Module 16

Code	Course/Module Title	ECTS	Semester
MPH21015	Atomic Physics	7	3
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97
Description			

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.

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Module Learning Outcomes

1- Knowledge of the atomic structure.
2- Identification the basic atomic physical laws
3- Enrich knowledge about atomic reaction

Module Aims

Get knowledge about the principles of Atomic Physics .

Module 17

Code	Course/Module Title	ECTS	Semester
MPH21016	Electromagnetics	4	3
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52
Description			

1- Method of giving lectures, explanation and clarification.
2- Student groups.
3- E-learning within the university.
5- Application of education.

Module Learning Outcomes

1- Enabling students to obtain knowledge and understand the topics of Electromagnetics.
2- Write and Solve wave equation
3-Show ability of make decisions and work alone or in team..

Module Aims

The main goal of study of Electromagnetic Theory course is to identify the basic principles of this theory, as follows: - General study of Vectors in the Cartesian, cylindrical and spherical coordinate systems. Also, addressing the Divergence and Gauss's theorem, Curl and Stokes theorems and Green's theorem. Study of the Electrostatic field in vacuum and addressing the Laplace and Poisson equations and their solutions in the Cartesian, cylindrical and spherical coordinate systems. Study of the Electrostatic field in the dielectric materials and addressing the phenomenon of polarization in these materials. In addition to calculating the Electrical displacement, Electrical susceptibility, Dielectric constant, and Laplace and Poisson equations in these materials. Study of Maxwell's equations in their differential and integral forms. Also,

study the propagation of plane electromagnetic waves in infinite media and the polarization of these waves.

Module 18

Code	Course/Module Title	ECTS	Semester
MPH21017	Thermodynamics	6	3
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, online lectures and home works and by considering type of simple experiments involving some sampling activities that bring attention of the students.

Module Learning Outcomes

1. Learning the basic concepts of thermodynamics and the properties of substances using property tables or property relations.
2. Understanding the different forms of energy, energy interactions by heat and work transfer, and the 1st law of thermodynamics.
3. Solving real world engineering problems related to energy by applying the 1st law thermodynamics to closed and open systems like piston-cylinder devices, turbines, and charging/discharging processes.
4. Understanding the 2nd law of thermodynamics and quantifying the performance of heat engines, heat pumps and refrigerators, reversible and irreversible processes
5. Defining entropy, developing entropy change relations, and deriving the increase of entropy principle,
6. Performing 2nd law analysis of engineering processes by quantifying entropy generation.
7. Analyzing some basic thermodynamics cycles like the Otto, Diesel, Brayton cycles for power production and the vapor compression refrigeration cycle for cooling applications..

Module Aims

1. The course aims to provide 2nd stage students with basic knowledge of thermodynamics.
2. To understand that everything related to energy and understand the concepts such as the first law of thermodynamics and the second law and its applications.
3. To enable students to access the science of thermodynamics by understanding how to correct engineering analysis and how to deal with laws, equations, illustrations and other data.
4. Enabling the student to be able to analyze, devise and draw conclusions.
5. theory through the application of techniques

6. Follow-up of scientific development through the Internet and keeping pace with scientific development by setting up experiments synchronized with theoretical topics.

Module 19

Code	Course/Module Title	ECTS	Semester
MPH22018	Materials Science	5	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62

Description

1. Establish a positive learning environment: Create an atmosphere of respect, collaboration, and inclusion.
2. Use a variety of teaching methods: Incorporate lectures, discussions, demonstrations, experiments, and hands-on activities to keep students engaged.
3. Set clear expectations: Explain the goals of the lesson and the criteria for success.
4. Provide feedback: Give timely and constructive feedback to help students learn from their mistakes.
5. Encourage active learning: Ask questions and provide opportunities for students to practice and apply their knowledge.
6. Promote critical thinking: Challenge students to think critically and analyze information.
7. Foster collaboration: Encourage students to work together to solve problems and share ideas.
8. Utilize technology: Incorporate technology into the classroom to enhance the learning experience

Module Learning Outcomes

1. Understanding the basic concepts in materials science (the purpose of studying materials science and engineering, classification of materials, interatomic bonds, metallic crystal structures, and crystal systems) and relating them to the materials' properties.
2. Understanding of the basic concepts in crystalline defects and analysis of the materials using optical and electron microscopes and x-ray diffraction characterization.
3. Compute ionic radii using unit cell dimensions.
4. Given the masses and atomic weights of two or more elements in a metal alloy, calculate the weight percent and atom percent for each element.

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Module Aims

1- Describe the important quantum-mechanical principle that relates to electron energies.
2- Briefly describe ionic, covalent, metallic, hydrogen, and van der Waals bonds.
3- Describe the atomic/molecular structure difference between crystalline and noncrystalline materials.
4- Draw unit cells for face-centered cubic, body-centered cubic, and hexagonal close-packed crystal structures.
5- Specify the Miller indices for a plane that has been drawn within a unit cell.

6- Classification of crystalline imperfections, calculate the weight percent and atom percent for each element in a metal alloy.
7- Explain the use of X-ray diffraction measurements in determining crystalline structures.

Module 20

Code	Course/Module Title	ECTS	Semester
MPH22019	Laser Physics	7	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

This course will be delivered through a combination between theoretical lectures in the classroom and experimental lectures in the Lab. The students will be receive the outcome of each lecture through discussions, videos related to the subject and questions. In addition, the information will be developed by self-learning through reading and searching to hand in the essay and home works.

Module Learning Outcomes

After studying this course, the student is expected to be able to:

- to give correct concepts of Laser in physics and differentiate between natural light and laser light
- to specify the types of lasers: Solid Laser, Gas Laser, Semiconductor Laser
- to give examples of laser applications: scientific, industrial, medical, communications and storage of information.
- Use algebra, trigonometry, and basic calculus, in solving problems in Laser physics and Laser cavity
- Provide detailed and accurate description of ABCD ray tracing in an optical cavity
- Classify the laser types according to active medium materials

Module Aims

1 - Description of the origin of the physical processes in laser systems.

2-Explanation of physics concepts for gain and amplification in different lasers

3–Explanation of the concepts of generation short pulses in laser devices

4 - using mathematical equations to calculate different physical parameters of laser systems

Module 21

Code	Course/Module Title	ECTS	Semester
KUS24020	Arabic Language 2	2	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	17
Description			

-1 تعلم العربية السليمة كونها اللغة الرسمية للوطن.
-2 اللغة جوهر الهوية ورمزها .
-3 توظيف المفردات الفصيحة في صياغة الاكاديمية للبحوث العلمية مترجمة بنظرها الفصيح.
التمكن من كتابة البحوث والمقالات ذات المحتوى العلمي الصرف باللغة العربية الفصحى.

Module Learning Outcomes

عند انتهاء مفردات المادة الدراسية يكون الطالب متمكنا من:

1- الكتابة السليمة خالية من الاخطاء
2- التعبير العلمي الاكاديمي الصحيح
3- استعمال المفردات الفصيحة توظيفا ونطقا
4- اضافة رصيد لغوي ومفاهيم جديدة لمعاني الكلمات
5- القدرة على المخاطبة الادارية في الطلبات الرسمية

Module 22

Code	Course/Module Title	ECTS	Semester
KUS24021	English Language 2	2	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	17
Description			

- Lectures
- Role playing
- Flipped classroom approach

- Time management
- Immediate feedback
  Group work

Module Learning Outcomes

1. Introduce themselves and others, ask and answer basic personal questions, and use the verb to be in simple sentences.
2. Describe possessions and family relationships, using possessive adjectives and singular/plural nouns correctly.
3. Talk about daily routines, times, and schedules while using the present simple tense and frequency adverbs.
4. Discuss abilities, skills, and permissions using can and can't, and learn functional language for making requests.
5. Describe places and homes, use there is/there are with prepositions of place, and ask for and give directions.
6. Talk about past experiences and events using the past simple tense (regular verbs) and vocabulary for historical events.
7. Express preferences, likes, and dislikes, and practice using verbs followed by -ing or to forms.
8. Ask about prices, and use countable/uncountable nouns with some, any, and much/many.
9. Describe current actions using the present continuous tense and compare it with the present simple.
10. Talk about future plans and intentions using going to, and learn vocabulary for travel and holidays.

Discuss past events using the past simple tense (irregular verbs) and share personal experiences.

Module Aims

1 Build a foundational vocabulary for everyday topics such as family, work, shopping, and travel.

2. Master essential grammar structures, including the present simple, present continuous, past simple, and basic prepositions.

3. Listen for key information in simple conversations and audio texts, such as directions, introductions, and short dialogues.

4. Practice speaking in structured activities, including introductions, asking questions, and participating in short exchanges.

5. Write simple sentences and short texts, such as postcards, emails, and personal descriptions.

6. Read and understand short texts, notices, and articles on familiar topics.

7. Use practical language for daily interactions, like ordering food, asking for directions, or making plans.

8.Explore cultural differences and similarities through lessons that introduce English-speaking traditions and lifestyles

Module 23

Code	Course/Module Title	ECTS	Semester
KUS24022	Applications of Computer Science	3	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
1	2	48	27

Description

1. Deliver theoretical content through structured lectures.
2. Use multimedia aids (e.g., presentations, videos) to enhance understanding of abstract topics like AI and networking.
3. Hands-on practice for email setup, document collaboration, and troubleshooting.
4. Lab-based exercises to simulate network setups and resolve network issues.
5. Demonstrations of e-commerce tools, such as secure online banking and mobile payment systems.
6. Collaborative problem-solving for troubleshooting real-life IT issues.
7. Group discussions on AI's impact on society and ethical challenges.
8. Present real-world scenarios of AI applications in healthcare, finance, and transportation.
9. Analyze security breaches and propose preventive measures for network security.

Module Learning Outcomes

1-Network Security:

- Describe different types of networks and their components.
- Implement basic security measures to protect network integrity.

2-Technical Troubleshooting:

- Apply diagnostic tools to identify hardware/software problems.
- Use practical methods to resolve technical issues.

3-E-Commerce:

- Utilize electronic banking services for transactions.
- Explain the mechanisms behind online banking and security.

4-Artificial Intelligence:

- Identify applications of AI in daily life, such as smartphones and healthcare.
- Discuss the ethical and societal challenges posed by AI technologies.

Predict future trends and innovations in AI.

Module Aims

1. 1 - Security and Networking:
   - To introduce students to computer networks, their components, and basic security principles.

- To prepare students for managing and mitigating network threats.

2. Computer Troubleshooting:
   - To equip learners with the ability to diagnose and resolve common hardware and software issues.
3. E-Commerce:
   - To familiarize learners with electronic banking services, including online and mobile banking.
4. Introduction to AI:
   - To provide an overview of artificial intelligence and its applications in everyday life.
   - To introduce key ethical considerations, societal impacts, and future developments in AI.

Module 24

Code	Course/Module Title	ECTS	Semester
MPH22023	Medical imaging	6	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

The module will be delivered through a combination of lectures, discussions and web-based learning. At the end of each lecture students will receive more specific learning outcomes for the lecture and be expected to undertake self-directed further reading and research

Module Learning Outcomes

1. Identify the role of medical physicist in the medical imaging process.
2. Understand the concept of ionizing radiation.
3. Distinguish between different interactions of x-ray with matter.
4. Understand the outcome of each x-ray interaction with matter.
5. Differentiate the main terms related to radiation attenuation.
6. Understand x-ray production process.
7. Appreciate the main features of x-ray images.
8. Classify x-ray modalities.
9. Review CT system design.
10. Differentiate between different modes of CT acquisition.
11. Comprehend the approach of nuclear imaging
12. Differentiate between different types of medial nuclear imaging.
13. Review the principles of ultrasound imaging.
14. Distinguish between different types of MRI.

Module Aims

1. To develop a basic understanding to the basic physics of medical imaging.
2. To understand the relationship between electromagnetic radiation and biological tissues.
3. To distinguish between the various interactions occurring in tissues and to be able to identify beneficial ones from the non-beneficial for medical imaging.
4. To gain basic understanding to medical imaging techniques employed in modern hospitals, including x-ray imaging, computed tomography, magnetic resonance imaging, ultrasound and nuclear isotope imaging.
5. To provide you with sufficient knowledge of introductory radiation biology and physics to allow you an appreciation of safe and optimal use of radiation imaging techniques.

Module 25

Code	Course/Module Title	ECTS	Semester
MPH22024	Medical Physics 1	5	4
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62
Description			

Students to the physical principles upon which medical physics depends and how to deal with them in a scientifically rigorous manner. Encouraging students to discover how the human body works with physical laws and its physiological and therapeutic effects by themselves through understanding the general laws of physics. This is done through scientific discussions in class as well as through practical application in hospitals and medical clinics.

Module Learning Outcomes

Obtaining a prominent scientific staff that tries to understand the nature of the physical work of the human body by being acquainted with each of

1- The influence of gravity forces on bone formation and blood circulation

2- The electrical influence on the nature of the body's work

3- The impact of heat on the nature of the body's work

4- Investigating mathematical physical relationships and their computerized diagnosis in illnesses caused by these impacts.

Module Aims

Cognitive objectives

A1- That the student understands the fundamental physics ideas connected to medicine.

A2- To comprehend the physical relationship and how to medically communicate it.

A 3- Relationship between physical attributes and medical device uses.

The fundamental aims.

B1 - Recognize the fundamental physical rules and their application to the human body.

B2 - Understanding of physical aspects influencing the human body and their relationship to the appearance of disease indications on the body.

Module 26

Code	Course/Module Title	ECTS	Semester
MPH31025	Biostatistics	3	5
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	0	33	42

Description

Biostatistics provides the basic framework for thinking about data in a rigorous fashion. This course is intended both as a refresher course and as a first course in the application of statistical thinking to biological problems. Descriptive and inferential statistics will be covered, with topics including confidence intervals, basic probability, discrete and continuous distributions, t-tests, correlation, regression, chi-square tests.

Module Learning Outcomes

define, explain the scope and concepts of Biostatistics and its applications.
· define data, know the common sources of data and understand the various methods of data collection and presentation. discuss to a reasonable level the probability theories and population distribution and their applications in health and health related fields.
· define and explain the various commonly used test statistics and their applications in analyzing data in public health
· acquire the necessary knowledge and skills for data analysis and interpretation of test statistic results.

Module Aims

. This course is intended both as a refresher course and as a first course in the application of statistical thinking to biological problems. Descriptive and inferential statistics will be covered, with topics including confidence intervals, basic probability, discrete and continuous distributions, t-tests, correlation, regression, chi-square tests.

Module 27

Code	Course/Module Title	ECTS	Semester
MPH31026	Medical Physics Devices1	4	5
Class (hr/w)	**Lect/Lab./Prac./Tutor/Semn**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52

Description

The main strategy that will be adopted in delivering this module is to acquaint the students with the physical principles on which medical devices depend how to deal with them in an accurate scientific method. Encouraging students to discover for themselves how medical devices work by understanding the general laws of physics. This is done through scientific discussions in the classroom and in the laboratory as well as through practical application in hospitals and medical clinics

Module Learning Outcomes

At the end of the course, students are expected to learn: 1. The basic theorem and laws to explain concepts, functions, behavior and characteristics of biomedical circuits and devices. 2. Formulate and solve electrical and mechanical problems related to biomedical devices. 3. Distinguish between therapeutic, diagnostic and analytical medical devices. 4. Work on device calibration and work on some devices directly in the examination.

Module Aims

This course introduces students to various medical devices that can be found in hospitals and medical institutions. The objective of this subject is to describe the principles, applications and the design of the medical instruments most commonly used in hospitals. Fundamental principles of operation and quantitative analysis and design of medical instrumentation systems for diagnostic and therapeutic medical applications are taught.

Module 28

Code	Course/Module Title	ECTS	Semester
MPH31027	Medical Physics 2	6	5
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**

2	3	78	72

Description

The main strategy that will be adopted in introducing this unit is to introduce students to the physical principles upon which medical physics depends and how to deal with them in a scientifically rigorous manner. Encouraging students to discover how the human body works with physical laws and its physiological and therapeutic effects by themselves through understanding the general laws of physics. This is done through scientific discussions in class as well as through practical application in hospitals and medical clinics.

Module Learning Outcomes

Obtaining a prominent scientific staff that tries to understand the nature of the physical work of the human body by being acquainted with each of 1- The influence of gravity forces on bone formation and blood circulation 2- The electrical influence on the nature of the body's work 3- The impact of heat on the nature of the body's work 4- Investigating mathematical physical relationships and their computerized diagnosis in illnesses caused by these impacts.

Module Aims

A1- That the student understands the fundamental physics ideas connected to medicine. A2- To comprehend the physical relationship and how to medically communicate it. A 3- Relationship between physical attributes and medical device uses. A4- Develop pupils' clinical skills. The fundamental aims. B1 - Recognize the fundamental physical rules and their application to the human body. B2 - Understanding of physical aspects influencing the human body and their relationship to the appearance of disease indications on the body. B3- Integration of fundamental principles and medical devices

Module 29

Code	Course/Module Title	ECTS	Semester
MPH31028	Analogue Electronics	6	5
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

This subject will be delivered to students through a series of lectures, tutorials, and hands-on activities. Lecture notes and technical demos will be included in the learning materials. Students should study both analogue and digital electronics concurrently throughout the year so that they are exposed to the differences and similarities in both domains and may better reflect on their experiences.

Module Learning Outcomes

1. Explain the energy levels, conductors, insulator and semiconductors 1. Recognize how semiconductors devices are built. 2. List the various terms associated with electronics circuits. 3. Summarize what is meant by a basic electronics circuit. 4. Discuss the reaction and involvement of atoms in semiconductors types. 5. Describe transistors, diodes, and how they work. 6. Define donors

and acceptors atoms in semiconductors. 7. Identify the basic circuit elements and their applications. 8. Discuss the operations of voltage amplifiers circuit. 9. Discuss the various properties of transistors and diodes. 10. Explain the efficiency of voltage amplifiers with deep analysis. 11. Identify the oscillators circuit analysis.

Module Aims

To develop problem solving skills and understanding of analog electronic circuits through the application of techniques. 2. To understand voltage, current, power in the transistors and diodes from a given circuit. 3. This course deals with the basic concept of analog electronics circuits. 4. This is the basic subject for all electrical and electronic circuits. 5. To understand and construct all voltage amplifiers problems. 6. To perform amplifiers types analysis.

Module 30

Code	Course/Module Title	ECTS	Semester
MPH31029	Anatomy	5	5
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62

Description

The main strategy that will be adopted in introducing this unit is to encourage students to participate in medical school visits and learn about anatomical models, while at the same time improving and expanding their critical thinking skills. This will be achieved through classes and interactive educational programs and by thinking about studying each organ of the body anatomically and by relying on anatomical samples in the laboratory in addition to modern education outputs, which include video clips explaining the mechanism of studying anatomy.

Module Learning Outcomes

1- The student will know the parts of the body and anatomy
2- Identify the function of each part and how to separate it from the other parts
3- Preparing the student to manufacture artificial human body parts in the future
4 - The soft skills objectives of the course.
5 - The student acquires the skill of human anatomy
6 - The student acquires knowledge of the organs and their vitality in the human body
7 - The student acquires the skill of making parts of the human body

Module Aims

1. Introducing the student to the science of human anatomy
2. Introducing the student to the parts of the body in detail
3. Introducing the student to the functions of all members and how to separate them
4. Linking the practical side with the theoretical side in order to facilitate and understand the material for the student

Module 31

Code	Course/Module Title	ECTS	Semester
MPH31030	Nuclear Physics	6	5
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.

Module Learning Outcomes

(a) Infer the existence and smallness of an atomic nucleus.

(b) Distinguish between the number of nucleons (mass number) and the number of protons (atomic number).

(c) show an understanding of how the conservation laws for energy and momentum in β decay were used to predict the existence of the neutrino (knowledge of antineutrino and antiparticles is not required)

(d) define the terms activity and decay constant and recall and solve problems using the equation $A = \lambda N$ and demonstrate an understanding that an element can exist in different isotopic forms, each with a different number of neutrons in the nucleus.

(e) Formulate the concept of conservation of nucleon number, charge, and mass-to-energy ratio in nuclear processes, and apply it to problem solving.

(f) Demonstrate your understanding of the concept of mass defect.

(h) Demonstrate your understanding of the concept of nuclear binding energy and its relationship to mass defect.

Module Aims

1. Understand the basic concepts of nuclear physics, with an emphasis on nuclear structure and the interactions of radiation with matter. Nuclear forces; the structure of the nuclear shell; alpha, beta, and gamma radioactive decays; interactions of nuclear radiation (charged particles, gamma rays, and neutrons) with matter; nuclear reactions; fission and fusion.
2. Learn about the designs and technologies of fission and fusion reactors, the types of nuclear accelerators and their main components, some applications of nuclear energy, and the techniques for producing electrical energy from fusion reactors, in addition to the concepts of elementary particles and the fundamental forces of nature.

Module 32

Code	Course/Module Title	ECTS	Semester
MPH32031	Wave Physics	4	6
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.

Module Learning Outcomes

- 1: The student should be able to describe the nature of a wave and explain the distinction between wave motion and particle motion.
- 2: The student should be able to identify and distinguish between contrasting types of waves.
- 3: The student should be able to describe the basic characteristics of waves such as frequency, wavelength, amplitude, period, and speed.
- 4: The student should be able to utilize mathematical relationships related to wave characteristics.
- 5: The student should be able to define wave speed and identify the variables which effect wave speed.
- 6: The student should be able to utilize the definition of wave speed to solve simple computational problems involving speed, distance and time.
- 7: The student should be able to perform straight-forward calculations using the wave equation.
- 8: The student should be able to interpret textual information and diagrams in order to perform mathematical analyses using the wave equation.
- 9: The student should be able to predict how alterations in the medium through which a wave is traveling will affect the properties of that wave.
- 10: The student should be able to predict the orientation of the reflected pulse at the boundary between two media.
- 11: The student should be able to recognize the distinction between constructive and destructive interference.
- 12: The student should be able to utilize the principle of superposition to predict the shape and amplitude of a wave form resulting from the interference of two waves.

Module Aims

The module aims to develop students' understanding of :

a) Compare between particle motion and wave motion in different types of waves.

b) Distinguish between pulse waves and periodic waves.

c) Distinguish between Longitudinal and Transverse waves.
d) Relate the speed, frequency and length of a wave.
e) Relate the energy carried by a wave to the amplitude of the wave.
f) Describe the interaction of sound and soft tissues.
g) Explain sound production and propagation.
h) Summarize the basic principles and techniques of ultrasound

Module 33

Code	Course/Module Title	ECTS	Semester
MPH32032	Biological Sensor	4	6
Class (hr/w)	**Lect/Lab./Prac./Tutor/semn**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52

Description

Providing students with basics and specifications

2. Encouraging students to discover how the understand biosensor works with physical laws and its physiological and therapeutic effects by themselves through

3. Understanding the general laws of physics. This is done through scientific discussions in class as well as through practical application in hospitals and medical clinics.

4. Forming discussion groups during the lectures to discuss the topics raised during the lecture

5. Explanation and clarification

6. Thinking questions such as what, how, when and why for specific topics

Module Learning Outcomes

1. Enabling students to obtain knowledge and understanding of the topics of principles of biosensors.
2. Obtaining a prominent scientific staff that tries to understand the biosensors and its applications
3. Enable students to obtain knowledge and understanding of biosensors applications and conduct various practical experiments.
4. Enable students to obtain knowledge and understanding of the use of basic

Module Aims

1. To understand the principles of biosensors and their applications in various fields.
2. To learn about the different types of biosensors and their working mechanisms.
3. To analyze the performance characteristics of biosensors, such as sensitivity, selectivity, and stability.
4. To evaluate the challenges associated with biosensor development, such as biocompatibility and signal interference.
5. To apply knowledge gained from biosensor studies to real-world problems in healthcare, environmental monitoring, food safety, and other fields.

Module 34

Code	Course/Module Title	ECTS	Semester
MPH32033	Quantum Mechanics	5	6
Class (hr/w)	**Lect/Lab./Prac./Tutor/semn**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62

Description

The main strategy that will be adopted in the delivery of this unit is to encourage students to participate in the exercises, while improving and expanding their critical thinking skills at the same time. This will be achieved through classes and interactive educational programs and by thinking about linking the course content with the devices and equipment that depend on the principles and laws of the course for their work.

Module Learning Outcomes

That the student understand the basic concepts of spectrum science.

1- To describe the relationship between the incident energy and the absorption spectrum.

2- The link between material properties and their emission spectrum.

3- To recognize the most important laws and relationships that link the spectrum of molecules.

4 - The soft skills objectives of the course.

5 - The applied side in practical hours

6 - Comprehension, comprehension and cognitive analysis.

7 - Observation and perception

Module Aims

1- Providing the student with a cognitive skill about the basic concepts of physics in general.

2- Introducing students to the most important principles of quantum mechanics.

3- Introducing the student to the wave properties included in the Schrödinger equation and the wave function.

4- Providing the student with knowledge of how to calculate the wave function and the time-dependent and non-time-dependent Schrödinger equation.

5- Introducing the student to the expected value and variance and deriving the mathematical relations for these phenomena.

6- Introducing the student to the mathematical laws and relations that relate to the constant of motion and the Hermitian influences.

Module 35

Code	Course/Module Title	ECTS	Semester

MPH32034	Physiotherapy Techniques	4	6
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52

Description

The main strategy that will be adopted in delivering this module is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.

Module Learning Outcomes

1- Knowledge of the techniques of physiotherapy.
2- Identification the refractive electrotherapy, thermotherapy, cryotherapy.
3- knowledge in principals of physiotherapy and medical physics.
4- Develop strong fundamentals of physiotherapy

Module Aims

1. To provide students with the cognitive skills based on scientific foundations and practical experience necessary to achieve the desired results in the physical therapy profession and gain patient satisfaction.
2. To provide students with and enable them to apply critical analysis skills to solve clinical problems by developing appropriate treatment plans based on patient needs.
3. To develop students' abilities to conduct clinical assessments and appropriate, evidence-based therapeutic interventions.
4. To acquire a comprehensive knowledge of internal, neurological, surgical, and pediatric diseases, for which physical therapy is an essential component of rehabilitation.
5. To encourage students to adhere to the Code of Professional Conduct and legal and ethical responsibilities when practicing physical therapy.

Module 36

Code	**Course/Module Title**	**ECTS**	**Semester**
MPH32035	Digital Electronics	6	6
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

Method of giving lectures, explanation and clarification.

2- Student groups.

3- E-learning within the university.

4- Application of education.

5- Experiential learning.

Module Learning Outcomes

1- Enabling students to obtain knowledge and understanding of the topics of digital electronics.
2- Enable students to obtain knowledge and understanding of logic gates practical experiments.
3- Enable students to obtain knowledge and understanding of the use of basic algebra laws in digital logic and their use in solving problems.

Module Aims

1-Providing the student with a cognitive skill about the basic concepts of digital electronics.

2- Introduce the student to the digital logic gates properties and methods of their application.

3- Providing the student with knowledge of how to calculate the laws of logic algebra and solving

4- Introducing the student to digital logic conversion systems.

Module 37

Code	Course/Module Title	ECTS	Semester
MPH32036	Physiology	6	6
Class (hr/w)	**Lect/Lab./Prac./Tutor/semn**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72

Description

The main strategy is to encourage students' participation in the exercises, while at the same time refining and expanding their critical thinking skills. This will be achieved through classes, interactive tutorials and by considering type of simple experiments involving some sampling activities that are interesting to the students.

Module Learning Outcomes

1. Identify what the meaning of physiology science and what the other sciences related with it
2.Identify how the body organs work and what the physiological function of it
3.Study the physiology of the hematopoiesis in human body
4.Study the cardiovascular system and iits components
5.Identify how the Central nerve system work and its components
6.Stud the Endocrinology of human body
7.Study how the muscular system works and what the physiological function of its

Module Aims

1. To acquaint the students with the components of the body cells and blood in order to prepare them for the practical life
2. To learning how the body organs, work together and what the physiological aspect of it
3. To learning the students to perform some blood physiological markers tests
4. Training the students to check some human body vital signs and how to check the human body organs functions

Module 38

Code	Course/Module Title	ECTS	Semester
MPH32037	Scientific Research Methodology	1	6
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
1	0	18	7

Description

يُعد هذا المقرر من أهم المقررات الدراسية كونه يمكن الطالب الجامعي من المهارات التي تساعده على انجاز بحث التخرج، وهو يعمل على إكسابه مجموعة من المعلومات والمعارف حول العلم والمعرفة، والبحث العلمي ومناهجه، وينمي الاتجاهات الإيجابية لدى المتعلم تجاه البحث العلمي، ويتحقق ذلك من خلال مجموعة من الأنشطة الفاعلة (طرائق وأساليب تدريس، ووسائل) كطريقة الحوار والمناقشة، والتعلم الذاتي، والبحث، والتطبيقات، مع استخدام الباوربوينت عند العرض، وتقييم الطالب من خلال المشاركة الصفية والتكليفات المصاحبة - الصفية واللاصفية - والاختبار النصفي والنهائي.

Module Learning Outcomes

1- تعريف الطالب بأساليب ومفاهيم اخلاقيات البحث العلمي والحفاظ على الامانة العلمية.
2- التعرف على التطبيقات المنهجية التي يدرسها الباحث والعمل على اتخاذ الاجراءات الصحيحة لحل المشاكل التي تواجه الفرد والمجتمع.
3- بناء القدرات والمهارات العلمية للطالب في كتابة البحوث العلمية .
4- تهدف المادة المعرفية الى تطبيق المنهجية العلمية ذات العلاقة بأسس ومتطلبات مناهج البحث العلمي.
5- تهدف المادة المعرفية الى ألتزام الباحث وعلى وجه التحديد الطالب بنزاهة وأدراك اهمية المنهج العلمي.
6 - تهدف المادة المعرفية الى معالجة مشاكل واقعية والعمل على ايجاد الحلول له.

Module Aims

1- تعليم الطالب بأساليب وأخلاقيات البحث العلمي ليستفيد من قدرته في كتابة البحوث العلمية وأيجاد الحلول المناسبة لحل المشكلات والمعضلات التي تواجه المجتمع .
2- العمل على زيادة القدرة في كتابة البحوث العلمية و أيجاد الحلول لمشكلة البحث.
3- معالجة المعضلات والمشكلات التي تواجه المجتمع .
4- جمع المعلومات بشكل دقيق وبالتالي دراستها فيما يخص المشكلة المبحوثة .

Module 39

Code	Course/Module Title	ECTS	Semester
MPH41038	Medical Physics 3	7	7
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

Module Learning Outcomes

1.The student should learn kind of radiations.
2. The student should learn the different effect of each kind of radiations
3. The student should learn the different Dosimetric Quantities
4. The student should learn the Relationship between Dosimetric Quantities
5. The student should learn the Types of Radiations Interaction with Matter
6. The student should learn Photoelectric Absorption in the matter
7. The student should learn the technique of Electron Beam Treatment Planning
8. The student should learn the X-ray Generator
9. The student should learn the Major Types of radiation Interactions with matter.
10. The student should learn the concept of Half-Value Layer and Tenth-Value Layer.

Module Aims

1. To develop the ability of the student.
2. To understand the aim of the medical physics.
3. This course deals with the basic concept of medical physics.
4. This is the basic subject for approximate the medical subjects.
5. Develop students' ability to understand the concepts of medical diagnosis.
6. Develop students' ability to understand medical treatment methods.

Module 40

Code	Course/Module Title	ECTS	Semester
MPH41038	Medical Physics Devices 2	7	7
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	97

Description

The main strategy that will be adopted in delivering this module is to acquaint the students with the physical principles on which medical devices depend how to deal with them in an accurate scientific method. Encouraging students to discover for themselves how medical devices work by understanding the general laws of physics. This is done through scientific discussions in the classroom and in the laboratory as well as through practical application in hospitals and medical clinics.

Module Learning Outcomes

1. Obtaining a distinguished scientific staff that works directly on the equipment and is a link between the attending physician and the medical engineer

2. Distinguish between therapeutic, diagnostic and analytical medical devices

3. Work on device calibration and work on some devices directly in the examination.

4. Medical analysis of accurate extracted readings by knowing therapeutic doses based on accurate mathematical calculations.

Module Aims

1. Understand the fundamental components of medical devices, as well as how to connect these components and integrate them with the human body to create an integrated application.
2. Connecting the device's physical application to the physics of the human body by connecting information about the physics of medical devices to medical physics and other materials such as biosensors, medical electronics, medical communications, biological materials, and life physics such as
3. Classify medical devices based on their physical action and the direct physical application of therapeutic, analytical, or diagnostic dosage estimations.
4. Developing the student's ability to calibrate the medical equipment from both a physical and technical standpoint.
5. enhance students' understanding of how to use physics to construct, enhance, or design a future medical device.
6. Inform pupils about the medical gadget's uses in the human body and how to physically read the device.
7. Obtaining an integrated scientific knowledge of the device by connecting the study material

with the rest of the subjects via knowledge of the electronic digital medical device, the mechanism of the device's operation, the sensors used in the device, the biological and biological materials used for each device, and the direct physical application of each device via the characteristics and physical features used for each device type.

Module 41

Code	Course/Module Title	ECTS	Semester
MPH41040	Laser in Medicine	5	7
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62
Description			

Module Learning Outcomes

1. To describe How does laser interact with biological tissue.
2. Define the eye parts and introduction to laser eye surgery.
3. Compare between four main surgery .
4. Explain the retinal surgery and causes of retina diseases
5. Compare between two main surgeries that uses to destroy kidney stones.
6. Explain why holmium laser is used in lithotripsy and how does it work.
7. Describe the types of cancers that laser can treat them.
8. Explain the types of laser used in laser therapy.
9. Compare between hard tissue laser and soft tissue laser.
10. Explain the factors affect the result in laser dermatology .
11. Compare between tattoo removal lasers.

Module Aims

1 - Introduce students to aspects of laser use in medicine considering basic physics, tissue interactions, diagnostics and therapeutics, and therapeutic guidelines.

2- Provide students with the technical basics of medical laser systems, associated instruments, modes of laser light delivery, and endoscopy.

3- Provide students with an introduction to application of lasers to diagnostics and disease treatment in medical sub-disciplines including: ophthalmology, dermatology, cardiovascular disease, urology, otorhinolaryngology, neurology, dentistry, and oncology.

Module 42

Code	Course/Module Title	ECTS	Semester
MPH41041	Radiation Protections	5	7
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	2	63	62
Description			

Module Learning Outcomes

1. Radiation Sources and Their Effects
2. Radiation Effects on Biological Tissue
3. Protection from External Radiation and Protection from Internal Radiation.
4. Personal Protective Equipment (PPE).
5. Regulations and Laws Regarding Radiation.

Module Aims

- Health effects of radiation on living organisms. Understand the types of radiation and their health effects.

- Know the protective measures to minimize radiation exposure.

- Apply protective techniques in various scientific and health-related fields.

- Understand the safety regulations and laws related to radiation

Module 43

Code	Course/Module Title	ECTS	Semester
MPH41042	Bio- Fluid	4	7
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52
Description			

Strategies in teaching biofluid are centered on the teacher and the students, It depends mainly on equipping the student with theoretical skills about blood microcirculation system and vessels also determine the diseases that related microcirculation through the

participation of students in preparing reports, assignments, seminars and projects, preparing lectures, solve examples. The student will gain knowledge about the laws of physics associated with the movement of blood through blood vessels represented by veins and arteries by determining density, velocity- pressure, volumetric flow rate and mass flow rate. The strategy of the bio fluid class is to increase students' awareness of the important laws of physics through which is determined the blood flow in the blood vessels, as well as the pressures at each region of the blood vessels

Module Learning Outcomes

1. Distinguish between the Newtonian and non-Newtonian fluids, laminar and turbulent flows.
2. Calculating the blood velocity, shear stress and viscosity and blood pressure at any point in the vessels.
3. Make the student able to determine the type of blood flow, whether it is laminar and turbulent flows in the vascular vessels.
4. Make the student distinguish between Arteries, Arterioles, Capillaries, Venules and Veins.
5. Distinguish between some vascular diseases such as atherosclerosis, stenosis.
6. Determine the difference between pulmonary circulation, Systemic circulation and Coronary circulation.
7. Study the Cardiac Cycle, Pressure, Flow and Heart Chambers Volume, Heart Valves Function and Mechanical Properties.
8. Defining the blood Rheology and blood types.

Module Aims

1. Understand the fundamental of body fluid and biofluid mechanics that representing by bodily fluid and blood components.
2. Increase students' knowledge about blood circulation system and the most important medical terms such as fluid kinematics, viscosity, Newtonian and non-Newtonian fluids , steady unsteady laminar and turbulent flows, Erythrocytes, leukocytes and thrombocytes, Arteries, Veins.
3. Provide the student with knowledge information about the Bernoulli equations, Hagen - Poiseuille equation, Steady Flow along tube.
4. Provide the student with knowledge information about Ematology and blood Rheology.
5. Enable the student to distinguish vascular diseases such as atherosclerosis, stenosis.
6. Provide the student with knowledge about Heart and Cardiovascular System, The Cardiac Cycle, Pressure, Flow and Heart Chambers Volume, Heart Valves Function and Mechanical Properties, Coronary Circulation.

Module 44

Code	Course/Module Title	ECTS	Semester
KUS47043	Ethics of Scientific Research	2	7

Class (hr/w)	Lect/Lab./Prac./Tutor	SSWL (hr/sem)	USWL (hr/w)
2	0	33	17
Description			

يذكر اسم المقرر لطلبة كلية العلوم / قسم الفيزياء الطبية / المستوى الرابع

ايجازاً مقتضياً لأهم خصائص البرنامج ومخرجات التعلم وفر وصف البرنامج الأكاديمي هذا المتوقعة من الطالب تحقيقها مبرهناً عما إذا كان قد حقق الاستفادة القصوى من الفرص المتاحة . ويصاحبه وصف لكل مقرر ضمن البرنامج.

Module Learning Outcomes

1. زيادة الوعي العلمي حول الاخلاقيات التي يجب التحلي بها من قبل الباحثين.
2. بيان الاخلاقيات الحميدة والسيئة من اجل تنمية الاولى ومكافحة وتجنب الاخيرة.
3. بيان كيفية اعداد البحوث العلمية مع مراعاة الامانة العلمية.
4. بيان كيفية العمل على بحث علمي رصين خال من السرقة العلمية والاستلال العلمي

Module Aims

1. بيان المقصود باخلاقيات البحث العلمي.
2. ايضاح سبيل النهوض باخلاقيات البحث العلمي.
3. تعزيز اخلاقيات الواجب اتباعها في اعداد البحوث العلمية

Module 45

Code	Course/Module Title	ECTS	Semester
MPH42044	Medical Physics 4	6	8
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72
Description			

Module Learning Outcomes

12. The student should learn history of CT.
13. The student should learn the units of Dosimetric Quantities

14. The student should learn the MR Imaging Principle.
15. The student should learn Introduction about Nuclear Medicine Physics.
16. The student should learn the technique of using Radiation in Nuclear Medicine.
17. The student should learn about Ultrasound Transducer.
18. The student should learn the Fundamental Radiation Protection Principles

Module Aims

1. Understanding the physical relationships whose applications are medical.
2. Studying the medical part that needs physics for diagnosis and treatment.
3. Training students to understand the link between physics and medicine.
4. Training students to use medical devices related to medical physics.
5. Describe the concept of medical physics.
6. Application of the laws of physics that have to do with the human body.
7. The study of radiation and its relationship to medical physics, whether in diagnosis or treatment.
8. Develop students' ability to understand the physical units of quantities used in treatment, especially their small parts due to their importance in determining doses.
9. Develop students' ability to study and determine doses. Explanation of all material in medical physics that includes almost all parts of

Module 46

Code	Course/Module Title	ECTS	Semester
MPH42045	Medical Image Analysis and Processing	6	8
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72
Description			

Module Learning Outcomes

To provide students with fundamental concepts of digital image processing and its applications in the medical field.
Introducing students to different types of medical images, their sources, and acquisition methods using various medical imaging modalities.
To enable students to understand medical image enhancement techniques and improve image quality for diagnostic purposes.
To equip students with skills in applying digital filtering techniques to reduce noise and correct distortions in medical images.
To introduce students to the fundamentals of medical image segmentation and feature extraction.
To develop students' ability to analyze medical images using modern digital image processing techniques.
To train students on the practical use of software and computational tools specialized in medical

image processing.
To enhance students' ability to integrate theoretical knowledge with practical applications in the diagnosis and analysis of medical images in accordance with scientific standards.

Module Aims

1. image Storage and Transfer Practical: Apply theoretical part using MATLAB.
2. Practical: Apply theoretical part using MATLAB.
3. Digital Image Practical: Apply theoretical part using MATLAB.
4. Noise Removal Practical: Apply theoretical part using MATLAB.
5. Rank filtering Practical: Apply theoretical part using MATLAB.
6. Edge Detection: The Canny Edge Detector Practical: Apply theoretical part using MATLAB.
7. Edge Detection: The Sobel Edge Detection Practical: Apply theoretical part using MATLAB.

Module 47

Code	Course/Module Title	ECTS	Semester
MPH42046	Nuclear Medicine and Radiotherapy	6	8
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	3	78	72
Description			

Module Learning Outcomes

1. The student understands radioactive nuclei and their use in nuclear medicine.
2. The student understands how radioactive nuclei are produced.
3. The student understands radiation doses and some clinical applications.
4. The student learns about radioactive pharmaceuticals.
5. The student understands the interactions of radiation with matter.
6. The student studies radiation dose measurement
7. The student studies radiation sources and radiation protection.
8. The student studies the biological effects of radiation.
9. The student should understand radiation therapy.
10. The student should be able to distinguish between nuclear medicine treatment devices.

Module Aims

1- Students are introduced to the subject of nuclear medicine and radiotherapy and its role in understanding modern treatment principles and their uses.

2- How to use this knowledge and techniques in treatment and link them to other scientific phenomena.
3- Gaining scientific knowledge through knowledge of the digital electronic medical devices used in nuclear medicine and radiotherapy, and how they work, through the physical characteristics and features used for each type of device.
4- Understanding the basic components of medical devices used in nuclear medicine and radiotherapy, as well as how to prepare radiation doses given to the patient for
5- examinations using a gamma camera, for example, or how to use nuclear therapy 6- using a gamma knife on the patient.

Module 48

Code	Course/Module Title	ECTS	Semester
MPH42047	Neurophysics	4	8
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
2	1	48	52
Description			

Module Learning Outcomes

1.The student understands the meaning of Neuro system and its structure.
2. The student understands the location and name the major structures of the mammalian brain (e.g., lobes, brainstem, cerebellum) and explain their primary functions
3. The student learns about the electrochemical process of how a signal starts, travels, and reaches the end of a neuron.
4. The student understand the Resting Membrane Potential and how ion channels regulate the voltage across the cell membrane.
5. The student understands the description of the stages of an action potential (depolarization to repolarization) and how neurons "communicate" at the synapse.
6. The student learns about the analyze how groups of neurons coordinate with each other to process complex information and maintain body functions.
7. The student understands the define of synaptic plasticity and explain how changes in neuronal connections lead to changes in behavior and memory.
8. The students trace the pathway of sound from the ear to the primary auditory cortex and identify the networks involved in hearing.
9. The student studies the map the flow of visual information from the retina to the visual cortex and understand how the brain interprets images.
10. The student Describe the "top-down" pathway of movement, from the motor cortex to the muscles via the spinal cord.

Module Aims

1. Provide the student with knowledge of the types of nerve cells

2. Teach the student how the nerve impulse is transmitted
3. Teach the student electrical nerves, resistance and capacitance of the nerve cell
4. - Teaching the student how the nerve impulse is transmitted between the different tissues and organs of the body
5. Teaching the student how to calculate the transmission speed of a nerve impulse and the most important mathematical equations used and how to apply them
6. Teaching the student the physical causes of neurological diseases and how to detect them

Module 49

Code	Course/Module Title	ECTS	Semester
MPH42048	Graduation Project	8	8
Class (hr/w)	**Lect/Lab./Prac./Tutor**	**SSWL (hr/sem)**	**USWL (hr/w)**
4	0	63	137
Description			

Module Learning Outcomes

1. Recruiting expert personnel to work in state institutions in all scientific research domains in the spirit of a research team.

2. Recognizing the significance of collaboration among peers in achieving a remarkable scientific research output

3. Theoretical study and practical research are equally important in achieving the findings that the team and the institution that will be working in hope of solving the problem that will be investigated.

4. Understanding that research projects are the first step in correcting thinking and the first step in producing and creating the job to be done.

Module Aims

1. Understanding the fundamental components of the material in a factor, as well as the technique of the project and the research that will be worked on in particular, and how to connect and integrate these components with the human body to build an integrated application.

2. Connecting the physical application of the equipment, produced material, or practical application to the physics of the human body by connecting all information and scientific and practical analysis of each part under consideration.

3. Improving the student's capacity to collaborate by identifying and diagnosing strengths and shortcomings while looking for the project's assigned section.

5. Improving pupils' grasp of how physics may be utilized to build or improve information.

6. Obtaining integrated scientific knowledge by linking the project's study material with the rest of the study materials, as well as the scientific analysis and how all the study materials are related in promoting systematic and prepared practical research for the purpose of obtaining a scientific product for the student and also preparing it in an important way for the labor market.

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