Biophysics Department

Medical Biophysics Program

B.Sc. Medical Biophysics

Offered by

Biophysics Department

Faculty of Science

Cairo University

2022

Biophysics Department

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A. Program Identification and General Information:

Program title and code: Medical Biophysics (MBP)
Program Nature: Special(New Program)
Department supervise the program: Biophysics Department
Total credit hours needed for completion of the program: 136 credit hours in 8 semesters (4 years)
The certificate awarded on completion of the program: Bachelor of Science (B.Sc.) in Medical Biophysics
Major tracks/pathways or specializations within the program: N/A

Professional occupations for which graduates are prepared:
Radiation protection – radioisotopes production laboratories – quality control assurance in checking linear accelerator output and other therapy machine – environmental protection agencies – medical biophysics research centers.

Name of program coordinator or chair: Professor in Specialty

B. Program Context:

The study of **Medical Biophysics** allows students to gain deeper understanding of the physical processes and principles used in medical and biomedical sciences. It cultivates thinking about living matter in '**physical terms**' and besides the development of medical devices, it is also crucial when working with both diagnostic and therapeutic equipment and processing biosignals in the widest meaning of the word. Graduates can go on to careers in healthcare, university education, and basic and applied research facilities. Thanks to a systemic training in research techniques, data analysis, statistical methods, and publishing research findings, they can work as independent experts in science and research.

- **Mission of medical biophysics program:**
  The program has a strong commitment to excellence to provide the students with the basic and applied scientific knowledge that is necessary both for further education and research in medical biophysics to serve and develop community.
- **Objectives of medical biophysics program:**
  The Medical biophysics degree program provides students with:
  1. Acquired basic knowledge of medical biophysics related to human anatomy and physiology of the body.
  2. The ability to perform the clinical support procedures and measurements required by the medical physicists.

3. Emphasizing the student's ability to retrieve, manage, and utilize information for solving problems for the implementation of radiation safety practices and procedures including the determination of radiation shielding requirements.
4. Practical, ethical, responsible, reliable, and dependable behavior in all aspects of their professional lives, and a commitment to the profession and society.
5. Understanding and build partnerships with the public and private sectors through the provision of studies and Consulting in the field of **Medical Biophysics**.

Goals and objectives	Major strategies	Measurable indicators
Acquired basic knowledge of medical biophysics related to human anatomy and physiology of the body	- *Demand a certain level of excellence in medical biophysics courses.* - *Developing students' skills through proper communication with the latest science by attending and participating in internal and external scientific forums*	- *Ratio of students to teaching staff* - *Proportion of teaching staff with verified doctoral qualifications* - *Students Satisfaction of the courses quality in the program* - *Employer satisfaction of the alumni abilities* - *Students' satisfaction of the Field experience training*
Develop the ability to perform the clinical support procedures required by a medical biophysicist	- *Attracting high quality Faculty/ Staff.* - *Improving Faculty/Staff skills by continuous training and professional development* - *Inclusion of students in research activities* - *Encourage critical thinking activities*	- *Students' satisfaction of the counselling, academic and professional services* - *Proportion of members of teaching staff with at least one refereed publication during the previous year* - *Number of papers or reports presented at academic conferences during the past year per member of teaching staff*

Emphasizing the student's ability to retrieve, manage, and utilize information for solving problems for the implementation of radiation safety practices and procedures including the determination of radiation shielding requirements	- *Encouraging applied research work for the benefit of society* - *Focus on communication and presentation skills* - *Participation in social and innovative activities that support community service*	- *Proportion of full-time students commencing under-graduate programs who complete these programs in minimum time specified for the program*
Practice, ethical, responsible, reliable, and dependable behavior in all aspects of their professional lives, and a commitment to the profession and society	- *Continue to promote effective student participation in scientific activities* - *Encourage participation of students in social and cultural activities.*	- *Rate of employer satisfaction of the alumni abilities* - *Rate of students' satisfaction of the Field experience training*
Understanding and build partnerships with the public and private sectors through the provision of studies and Consulting in the field of medical biophysics	- *Continue to promote effective student participation in scientific activities* - *Encouraging applied research work for the benefit of society*	- *Rate of employer satisfaction of the alumni abilities.* - *Rate of students' satisfaction of the field experience training*

- **Distinctive features of the program**:
  The following table shows the types of distinctive features of the **Medical Biophysics Program**:

Distinctive features	Current situation
The scarcity of specialization	The Department of Biophysics – Faculty of Science - Cairo University is the only department in Egyptian universities at the level of the Republic that offers this program
The compatibility of the specialty with the needs of the labor market	Highly compatible with the needs of the labor market
Link graduation time historical foundation	The Department of Biophysics of the newest sections of the Faculty of Science at Cairo University, was established in the beginning of 1981-1982
The demand of students to the department	The number of students wishing to join the program from inside and outside Egypt and from different nationalities is in regular increase
Job opportunities	Job opportunities available for graduates of the program in the

	following areas: - Biophysics groups in Egyptian and international universities - Some sections and divisions of the National Research Center - Medical forensic authority - Ministry of Health Laboratories - Regional Centre for Radioisotopes - Radiation Research and Technology Center - Laser Institute, Cairo University - Serum and Vaccine Laboratories - The quarantine authority - Environmental radiation specialist in airport - Pharmaceutical companies - Institute of Oncology - Bahia Hospital - 57357 Hospital - Radiotherapy centers - Dosimetry and calibration of medical instruments
The geographical location of the institution	The department derives geographical importance because it is located within the campus of Cairo University in Giza Governorate and provides both the Oncology and Nuclear Medicine Centers of the Faculty of Medicine of the University and the Oncology Institute of the University, which give the students of the program the advantage of practice and compatibility with the needs of the labor market

- **Program justification:**

Many medical physicists are working in the areas of diagnosis and treatment of cancer patients with medical team in collaboration with the physician processing a patient treatment plan by using radioactive materials internally or externally and make the necessary calculations to ensure the arrival of radiation to the tumor and avoid healthy tissues In the field of nuclear medicine they are concerned with the preparation of isotopes used in diagnostic imaging and determine how to transmit them in patient members according to metabolic rates per patient separately. Moreover, the medical biophysicist works to maintain the action readiness of diagnostic equipment and radiotherapy devices and to ensure their efficiency and free of errors. They also deal with sources of radiation and adjust their devices and design what is required to prevent employees from radiation hazards. The need of labor market to well-trained specialized employees in planning and treatment of various cancer tumors as well as the use of the latest developments dosimetry and radiation protection is very important especially with the rapid

development in the technologies. Therefore, this program is close in terms of the need for the labor market and the applications of practical and mental skills and also earns the skills of communication to advice students of this specialization at a high level in their fields and this is what everyone is looking for

- **The importance of the program and the extent of the labor market needs of medical biophysicist:**
  The work of medical biophysicists includes several activities, the most important of which are: clinical service, consultation, research, and development, teaching and management. The involvement of the medical biophysicist in all or some of these activities depends on the workplace, his background and his personal interests. For example, most of the activity of the medical biophysicist working in a non-teaching hospital or clinic in the clinical service is the daily clinical practice, while the medical biophysicist working in an academic institution is most of its academic activities such as teaching and scientific research. Academic study alone is not enough to form a physical medical biophysicist. He needs practical experience in dealing with medical problems and various devices in his field. This experience can be obtained through a structured training program (Residency Internship Program).

- **The nature of the program in terms of its academic and professional focus and scientific approach:**
  Medical biophysics departments usually consist of four divisions: radiation therapy, diagnostic imaging physics, nuclear medicine physics and radiation protection and may be accompanied by a research center that supports all these units in addition to modern biophysical research in nanomedicine, usually hospital expertise is concentrated in the following:
  - **Radiation biophysics:** Preparation of radiotherapy plans, calculation of radiation dose, calibration, quality assurance tests, acceptance tests and operation of linear accelerators and short therapy systems used in treating patients radiologically
  - Imaging biophysics: providing biophysical support to the radiotherapy unit, operating rooms, and dental unit, through quality assurance, admission and operation test results and consulting services
  - **Health biophysics:** Application of radiation protection program for patients, workers, community members and the environment, monitoring radiation exposure and radiation dose
  - **Biomedical research:** Provides biomedical foundations for multiple medical radiation uses and other health fields and studies the determinants of radiation sensitivity genes for cancer patients
  - **Secondary standard dosimetry laboratory:** SSDL offers high-precision calibration of radiometers and ionization chambers and is recognized by IAEA and WHO.

- **Clinical nuclear medicine services:** Include diagnostic flicker tests, bone density calculation, radioactive material analysis, cell differentiation using various medical devices such as a dual-unit optical bone density meter and a sensor for measurements within the patient's body, a gamma-ray meter for measurements on patient's body samples, and a radiation dose calibration device.

C. Program Description:

Medical Biophysics is the application of physics to the diagnosis, treatment and prevention of human disease and disability. The traditional areas of medical biophysics have been in radiotherapy, nuclear medicine and in health physics, but with the rapid translation of new physical techniques into medical instrumentation, medical physicists became essential part in clinical fields such as those using magnetic resonance imaging (MRI), ultrasound, measurement of the body's electric and magnetic fields, positron emission tomography, pulmonary physiology, cardiology, neurology, ophthalmology and biomedical sensors and implants.

The medical biophysicist is an important member of the medical team in many modern medical and health facilities. Furthermore, they are involved in the calibration, maintenance and use of the various instruments and are often required to modify and improve instruments for research purposes.

In addition, there has been a high demand for medical biophysicists to work in the field of environmental and occupational health hazards and estimate risk factors.

The mission of the Medical Biophysics program is to prepare undergraduate students who possess entry-level skills for employment in medical imaging and diagnostics facilities. Students graduating from this program will be specialized in one of the following medical careers:

1. Various diagnostic radiology facilities including:
   a. Computer Tomography (CT)
   b. Magnetic Resonance Imaging (MRJ)
   c. Infra-red (IR) Imaging
   d. Ultrasound Scanning
2. Nuclear Medicine
3. Radiation Treatment Planning (RTP) and Linear Accelerators
4. Radiation Hazards and Health Physics

D. Program Learning Outcome:

Summary description of the Knowledge Skills to be acquired and on completing the medical biophysics program, students will be able to:

a1. Acquire the major aspects of nature and subject of medical biophysics and the application of physics to medicine.
a2. Recognize matter in various forms, including crystals, semiconductors, atoms, nuclei and understand the principles of laser and its application in medicine.
a3. Recognize Bioinformatics in order to know how to analyze data which is used to diagnose with the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear
a4. Acquire different quantitative, mathematical science and physical tools analyze problems and list some foundations of systems theory to solve and analysis different problems.
a5. Recognize the nature, properties, dosimetry of radiation and basics of radiation protection and also medical effects of ionizing and non-ionizing radiation.
a6. Acknowledge the principles of physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical biophysics.

Summary description of the Cognitive Skills to be acquired and on completing the Medical biophysics program, students will be able to:

b1. Recognize mathematical and physical formulas and demonstrate skills of critical thinking and analytical reasoning to solve problems in medical biophysics and related fields of studies.
b2. Interpret the data obtained from testing, diagnostic instruments such as MRI, X-rays, ultrasonic images, CT images and gamma camera images.
b3. Analyze and apply the mathematical expressions in evaluating and understanding of essential facts, concepts, principles, and theories of medical biophysics.
b4. Formulate and test hypotheses using appropriate experimental design and analysis of data (Computer simulation) and integrate IT-based solutions into the user environment effectively.

Summary description of the Interpersonal Skills and Responsibility to be acquired and on completing the Medical biophysics program students will be able to:

c1. Analyze and evaluate information by using computational tools to interpret experimental data relevant to medical biophysics by using packages from different theoretical and experimental resources, and perspectives.
c2. Operate some medical instruments such as that used for the diagnosis of different diseases in medical centers and demonstrate competency in laboratory techniques and safety.
c3. Use scientific literature effectively and prepare technical reports that for individual student or making a group of researchers.

Summary description of the Communication, Information Technology and Numerical Skills to be acquired and on completing the Medical biophysics program students will be able to:

d1. Illustrate and employ the processes of scientific inquiry and research methods through effectively use information and communications technology (IT) tools and use the basic software, to ensure globally understand of medical biophysics issues.
d2. Demonstrate scientific concepts and analytical argument, in a clear and organized way, verbally and in writing.
d3. Implement all kinds of relevant information in medical biophysics through the use of local and internationally accessible libraries, information database, and electronic data and use that information in problem solving activities.
d4. Work independently and demonstrate the ability to manage time and to work as a part of a team, and learn independently with open–mindedness to learn how solve the daily life problems.

Comparison between Medical biophysics Program and Physics with Medical physics Program Learning Outcomes	
Medical biophysics Program	**Physics with Medical physics Program (**University College London, and University of London**)**
a1- Acquire the major aspects of nature and subject of medical biophysics and the application of physics to medicine **a2-** Recognize matter in various forms including crystals, semiconductors, atoms, nuclei and understand the principles of laser and its application in medicine **a5-** Understand the nature, properties, dosimetry of radiation and basics of radiation protection and medical effects of ionizing and non-ionizing radiation **a6-** Know the principles of physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical biophysics	1- Theoretical structure of the core topics in Physics and Medical physics, with a selection of advanced research topics related to both medicine and surgery

a4- Define different quantitative, mathematical science and physical tools to analyze problems and list some foundations of systems theory to solve and analysis different problems	2- The mathematical basis of Physics
a3- Use bioinformatics to know how to analysis data which is used to diagnose with the aid of different medical devices such as X- ray machines, gamma camera, accelerator, and nuclear magnetic resonance	3- The structure of compiled computer programs
b1-Apply mathematical and physical formulas and demonstrate skills of critical thinking and analytical reasoning to solve problems in medical biophysics and related fields of studies **b3-** Apply the mathematical expressions in evaluating and understanding of essential facts, concepts, principles, and theories of medical biophysics	1- Application of their knowledge to unseen problems
b2- Interpret the data obtained from testing diagnostic instruments such as MRI, X-rays, ultrasonic images, CT images and gamma camera images **b4-** Formulate and test hypotheses using appropriate experimental design and analysis of data (Computer simulation) and integrate IT-based solutions into the user environment effectively	2. Ability to combine mathematics and verbal explanation in a coherent rigorous argument
c1- Analyze and evaluate information by using computational tools to interpret experimental data relevant to medical biophysics by using packages from different theoretical and experimental resources, and perspectives	1- Carry out laboratory experiments to demonstrate physical principles and measure constants of Nature 2- Use spreadsheet package to present and calculate physics results

c2- Operate some medical instrumentation such as that used for diagnosis of different diseases in medical centers and demonstrate competency in laboratory techniques and safety	6- Use compiled or interpreted computer languages to write original programs 7- Design an experiment and/or computer-based investigation to study and solve an open-ended research problem
c3- Use scientific literature effectively and prepare technical reports that for individual student or making a group of research	4- Report experimental results clearly and methodically 5- Use computer packages for word processing, webpage management and manipulation of mathematical functions
c4- acquire ethical, social and legal responsibilities concerning medical	3- Present results with appropriately calculated errors
d1- Illustrate and employ the processes of scientific inquiry and research methods through use effectively information and communications technology (IT) tools and use the basic software, to ensure global understand of medical biophysics issues **d2-** Represent scientific concepts, and analytical arguments, in a clear and organized way, verbally and on writing **d3-** Implement all kinds of relevant information in medical biophysics using local and internationally accessible libraries, information database, and electronic data and use that information in problem solving activities **d4-** Work independently and demonstrate the ability to manage time and to work as a part of a team and learn independently with open–mindedness to learn how solve the daily life problems	1- Write clear accounts of scientific subjects at a level appropriate to audiences ranging from complete lay-people to fully qualified colleagues.

E. Academic Standards of the Program:

	NARS	X	**ARS**	X	**Benchmark**

The Physics with Medical physics program Learning Outcomes of University College London, University of London as an external benchmark is used to compare the Medical biophysics program ILO's as followings:

F. Program Duration/Number of Credit Hours:

4 years (8 Levels) / 136 Credit hours

G. The structure and Components of the Program:

Courses' group	Numbers of hours	Percentage (%)
Basic Sciences	29	21.3
Social and Human Sciences	٨	5.9
Specialty Sciences	73	53.7
Other Sciences	26	19.1
Total	136	100

H. The Medical Biophysics Program Curriculum:

MBP	**Medical Biophysics**
Ph	**Physics**
Mt	**Math**
Bi	**Biology**

- First level – First semester: 15 Credit hours (15 Compulsory + 0 Elective + University requirements)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP111	Fundamentals of Medical Biophysics (I)		2	2	-	3	C
MBPPh112	General Physics (I)		2	2		3	C
MBPMt113	Mathematics (I)		2		2	3	C
MBPCh114	General Chemistry		2	2		3	C
MBPBi115	Cell biology		2	2		3	C

- First level – Second semester: 15 Credit hours (15 Compulsory + 0 Elective + University requirements)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP121	Fundamentals of Medical Biophysics (II)		2	2	-	3	C
MBPPh122	General Physics (II)		2	2		3	C
MBPMt123	Mathematics(II)		2		2	3	C
MBPCh124	Biochemistry		2	2		3	C
MBPBi125	Molecular Biology		2	2		3	C

- Second level – Third semester : 16 Credit hours (16 Compulsory + 0 Elective)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP211	Radiation Biophysics (I)	Fundamental of Medical Biophysics (I & II)	3		-	3	C
MBP212	Radiobiology		٣			3	C
MBP213	Human Anatomy		2	2		3	C
MBPPh214	Quantum Mechanics	General Physics (I & II)	2			2	C
MBPPh215	Electromagnetism	General Physics (I & II)	3			3	C
MBP216	Medical Biophysics Laboratory (I)		0	4		2	C

- Second level – Fourth semester - Fourth level: 16 Credit hours (16 Compulsory + 0 Elective)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP221	Laser in Medicine	General physics (II)	2		-	2	C
MBP222	Health Physics	Radiation Biophysics (I)	2			2	C
MBPPh223	Nuclear physics	General Physics (II)	2			2	C
MBP224	Biomechanics	General Physics	2			2	C

		(I & II)					
MBP225	Ultrasound in Medicine		2			2	C
MBP226	Electronics and instrumentation	General physics I	2			2	C
MBP227	Medical Biophysics Laboratory (II)		0	4		2	C
MBP228	Communication and Control Biophysics		2			2	C

- Third level – Fifth semester :18 Credit hours (16 Compulsory + 2 Elective)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP311	Radiation Biophysics (II)	Radiation Biophysics (I)	3		-	3	C
MBPMt312	Biostatistics		2		2	3	C
MBP313	Physics of Radiation Therapy (I)		3			3	C
MBP314	Radiation Protection	Radiobiology	2			2	C
MBPBi315	Human Physiology		2			2	C
MBP316	Medical Biophysics Laboratory (III)		0	6		3	C
MBP317	Physics of Brachytherapy	Health Physics	2			2	E
MBP318	Magnetic Resonance Imaging	Electro-magnetism	2			2	E

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- Third level – Sixth semester : 18 Credit hours (16 Compulsory + 2 Elective)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP321	Physics of Medical Imaging (I)	Radiation Biophysics (II)	3		-	3	C
MBP322	Computational Biophysics	Quantum Mechanics	2			2	C
MBP323	Radiation Dosimetry and Measurements	Radiation Biophysics (II)	3			3	C
MBP324	Physics of Nuclear Medicine	Radiation Biophysics (II)	٣			3	C
MBP325	Medical Biophysics Laboratory (IV)		0	6		3	C
MBP326	Molecular Spectroscopy		2			2	C
MBP327	Fundamentals of Nanotechnology in Imaging and Therapy		2			2	E
MBP328	Application of biosensors in medical biophysics		2			2	E
MBP329	Radiation planning	Physics of Radiation Therapy (I)	2			2	E
MBP330	Bioelectronics	Electronics and instrumentation	2			2	E

- Fourth level – Seventh semester : 18 Credit hours (16 Compulsory + 2 Elective)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP411	Physics of Radiation Therapy (II)	Physics of Radiation Therapy (I)	2		-	2	C
MBPMt412	Computer Applications in Medical biophysics	Computational Biophysics	٢		٢	3	C
MBP413	Biomaterials		2			2	C
MBP414	Physics of Medical Imaging (II)	Physics of Medical Imaging (I)	2			2	C
MBP415	Medical Biophysics Laboratory (V)		0	6		3	C
MBP416	Molecular Imaging		2			2	C
MBP417	Research Project		2			2	C
MBP418	Medical physics calibration and quality control		2			2	E
MBP419	Selected topics in medical biophysics		2			2	E

- Fourth level – Eighth semester : 12 Credit hours (10 Compulsory + 2Elective)

Code	Course name	Requirement	Lecture	Practical	Tutorial	Credit hours	Compulsory or Elective
MBP421	Field Training	Department acceptance		18	-	6	C
MBP422	Research Project		2	2		2	C
MBP423	Ethics in Medical Biophysics		2			2	C
MBP424	Computational radiation transport	*Computational Biophysics*	2			2	E
MBP425	Programming Methods for Radiotherapy treatment planning	Radiation planning	2			2	E

I. Courses' Description:

First level:

- ***Fundamentals of Medical biophysics (I) (MBP111):***

This course is an introductory to medical biophysics. It covers many subjects as an introductory. It provides information about electric through the vital body, the nervous system and its neurotransmitters and voltage nerve-wracking. It deals with diagnostic X-ray physics: X-ray generation and absorption and X-ray imaging. Basic radiometric devices and their medical applications: Geiger counter, optical multiplier tube, pulse height analyzer, gamma ray camera, radiation dosages in nuclear medicine. Radiation protection in medicine: natural and industrial sources of ionizing radiation, biological effects of ionizing radiation, radiation protection units and their limits in nuclear medicine. Applications of heat and cold in medicine: thermal therapy using both: heat conduction method, infrared and radio waves, microwave and ultrasound, the use of extremely low temperatures in medicine, blood and tissue preservation and cryopreservation. Use of light in medicine: general properties of light and measurement of light units, applications of visible light in medicine, flexible fiber optics, applications of ultraviolet and infrared radiation in medicine, infrared imaging, laser and medical applications, microscopes.

- ***General Physics (I) (MBPPh112):***
  The main purpose of the course to covering some advanced physics principle in Mechanics, Vibration and waves, Thermodynamics, Electricity and magnetism and Light optics. This course provides a conceptual and experimental background in physics sufficient to enable students to take courses that are more advanced in related fields.

- ***Mathematics (I) (MBPMt113):***
  This course provides a unique introduction to a course in single-variable calculus. Key topics of the course include real numbers, functions and graphing, limits and continuity, derivatives, derivative applications, integrals, and applications of integration. Concepts of differential and integral calculus are applied to trigonometric, inverse trigonometric, and transcendental functions.

- ***General Chemistry (MBPCh114):***
  The course covers the principles of organic, physical, and inorganic chemistry applying lab experiments to give a clear application to the radiopharmaceuticals.

- ***Cell biology (MBPBi115):***
  The course covers introduction to biology, biological molecules, cell and cell membrane, enzymes, metabolism, cellular respiration, photosynthesis, cellular reproduction: mitosis and meiosis, Mendelian genetics, chromosomes, and gene expression. This course provides a conceptual and experimental background in biology sufficient to enable students to take courses that are more advanced in related fields.

Second level:

- ***Fundamentals of Medical biophysics (II) (MBP121):***
  Energy, work, and strength inside the body: saving energies inside the body, switching energies in the body, work and strength, basic systems for the loss of thermal energies in the body. Physics of the eye and vision: introductions of the sense of vision and the properties of special vision, factors of image collection in the eye, reticular as a member of photosensitivity in the eye, general types of light receptors, vision defects and Correction, contact lenses and vision efficiency. Sound in medicine: general properties of sound, reflection of sound waves, stethoscope (doctor's hearing), ultrasound of the body: Sound Scan by a)), sound scan by B), sound scan to assess movement by M)), Doppler effects, ear and hearing physics, hearing test, deafness and hearing aids, biophysics of structural dilemmas. Flexibility, the study of the effect of loads on muscle contraction, tension in the

muscles. Hemodynamics: the hydraulic principle of flow and its relation to heart function, heart flow and blood pressure, the Landquist phenomenon, the bozayle equation and the bernoni equation and their relation to hypertension. Biomechanics of the lung: surface tension and its relationship to the lung, the effect of detergents on the breathing process, the relationship between air flow, pressure, and resistance during the breathing process.

- ***General Physics (II) (MBPPh122):***
  The main purpose of the course to covering some advanced physics principle in nuclear physics, Ionizing radiation. General description of a Laser. Laser principle and Lasers as spectroscopic light sources.

- ***Mathematics (II) (MBPMt123):***
  This course covers the basic mathematical tools used in physical science and engineering: Vector analysis, partial differentiation, power and series, differential equations, special functions, integral transforms, and complex analysis.

- ***Biochemistry (MBPCh124):***
- This course covers the principles of biochemistry applied to biological systems. It also covers different cycles of metabolism within human).

- ***Molecular Biology (MBPBi125):***
  The course discusses Introduction to DNA and genes, Molecular cloning methods, Molecular tools for studying gene expression, DNA replication and recombination, Overview of DNA translation and translation control, DNA, Transcription in prokaryotes and DNA protein interactions.

Third level:

- ***Radiation Biophysics (I) (MBP211):***
  This course is interested in study the interactions and energy deposition by ionizing radiation in matter; concepts, quantities, and units in radiological physics. The use of radioactive sources for radiotherapy including materials used, source construction, dosimetry theory and practical application, dosimetric systems, localization, and reconstruction. The course covers low does rate, high dose rate and permanently placed applications.

- ***Radiobiology (MBP212):***
  The course reviews the concepts relating to radiation effects on cellular, organ, system, and levels within the entire body. In addition to the effects of radiation on normal tissues and effects on malignant cells. The course also includes significant detail regarding cell cycle effects, cell signal

induction, and molecular aspects germane to radiotherapy and its effects on tissue. Emphasis of the theories and principles of tolerance dose, time-dose relationships, fractionation schemes and the relationship to clinical practice of radiation therapy.The effects of radiation on the developing embryo and fetus at each stage were also discussed.

- ***Human Anatomy (MBP213):***
  This course aims to thoroughly acquaint the student with detail studies and understanding of anatomical terms, anatomical structures of human body. Additionally, the course covers body planes and lines, surface anatomy, terminology applicable to skeletal, radiographic, regional, and cross-sectional anatomy.

- ***Quantum Mechanics (MBPPh214):***
  This course covers wave particle duality, probability, and the Schrodinger equation, in addition to the general structure of wave mechanics, angular momentum, spin, the Schrodinger equation in three dimensions and application to hydrogen atom.

- ***Electromagnetism (MBPPh215):***
  This course deals primarily with a vector calculus-based description of static electric field in case of fixed charges, volume and surface charge distribution, dipole, multipole, conductor, and dielectric beside the calculation of the electrostatic potentials in each case. The calculation of the electric field by applying Gauss's law for fixed charges and dielectric materials. Also, it concerns with the study of the polarization, dielectric constant, and the boundary conditions at the interface at the two different dielectric media.

- ***Medical Biophysics Laboratory (I) (MBP216):***
- This course provides with experiments related to polarization, principles of electromagnetism and some applications. Principles of electric circuits and some bio-applications.

Fourth Level:

- ***Laser in Medicine (MBP221):***
  This course aims to describe the uses of LASER in medicine and surgeries. It covers how LASER is formed and the associated conditions for LASER formation, various types of LASER, how the Laser

beam is transferred in fibers and the biological effects on the different human tissues. Moreover, it introduces the laser applications in ophthalmology as an example.

- ***Health Physics (MBP222):***
  An introduction to the field of health physics, which concentrates on the use of radiation and personal exposures in the categories of environmental radiation, medical applications, consumer products, industrial uses, research uses, and military uses, moreover, various types of sensors and measurement apparatus used for the calibration of medical imaging and therapy systems.

- ***Nuclear Physics (MBPPh223):***
  The course will cover the principle of nuclear physics, such as Nuclear Properties of the matter, Liquid Drop and shell Model, radiation. This course will provide a conceptual and experimental background in physics sufficient to enable students to take courses that are more advanced in related fields.

- ***Biomechanics (MBP224):***
  This course concerns with static forces, friction for human body, translational and angular motion for the human body, and the motion of fluids in human body.

- ***Ultrasound in Medicine (MBP225):***
  This course covers the basic principles of ultrasound waves in addition to the generation and detection of waves and components of medical devices. It aims to represent medical applications of different ultrasound modes' images and the image artifacts.

- ***Electronics and instrumentation (MBP226):***
This course will provide basic knowledge for circuit analysis, semiconductor diodes and transistors, small signal models, and operational amplifiers. This course concerns with resistive circuits and determine currents and voltages, the transient behavior of RC and RL circuits, phasors and complex impedances to analyze steady state responds, operations of diodes, transistors and amplifiers, noise measurements, logic gate and analog to digital conversion and application.

- ***Medical Biophysics Laboratory (II) (MBP227):***
  This course provides experiments related to biomechanics, interaction of radiation with matter and principles of radiation protection.

- ***Communication and Control Biophysics (MBP228):***
  This course covers an introduction to linear systems and control theory as applied to organ system regulation and adaptation. Emphasis is placed on biophysical models of the respiratory and

cardiovascular systems, and interactions with medical devices. (A system engineering approach to biophysical problems.)

Fifth level:

- ***Radiation Biophysics (II) (MBP311):***
  This course is interested in studying how the internal and external radiation doses and different ways to measure the radiation doses and the study of the nature of the radioactive contamination and how to make decontamination factor.

- ***Biostatics (MBPMt312):***
  The course covers descriptive statistics, graphical data summary, sampling, statistical comparison of groups, correlation, and regression.

- ***Physics of Radiation Therapy (I) (MBP313):***
  This course provides the necessary practical and theoretical background for the support of a radiotherapy physics service within radiotherapy. The course concerns with the basis for understanding physical principles within radiotherapy, focusing on clinical application. Equipment for generating/delivering ionizing electron- and photon radiation, clinical radiation dosimetry, characteristics and specifications of radiation fields, treatment planning (volume definitions, field setup, fractionations, modern techniques, and dose calculation algorithms), quality assurance, and possibilities and limitations related to treatment modalities like particle therapy.

- ***Radiation Protection (MBP314):***
  This course is designed to demonstrate and consolidate the basic radiation protection physics concepts as the information about Radiological quantities and units, acquire information about External Radiation Safety, study the Shielding against ionizing radiation, study the Internal Radiation Safety, and acquire radiation safety information about non-ionizing radiation.

- ***Human Physiology (MBPBi315):***
  This course concerns with Structural levels of organization within the human body; tissues and the body organs. It covers the structure and function of different systems: circulatory, lymphatic, hematological, integumentary, respiratory, urinary, digestive, endocrine, nervous, musculoskeletal, reproductive.

- ***Medical Biophysics Laboratory (III) (MBP316):***

The course covers characterization of different radiation measurement devices, calculation of dead time, absorption response of different materials when exposed to different types of ionizing radiation. Moreover, the course concerns with external beam radiation protection.

- ***Physics of Brachytherapy (MBP317):***
  This course provides information about the physics of radioactive sources used in brachytherapy and the difference between brachytherapy and radiotherapy. It also covers the physical principles of different implant systems and their medical applications, in addition to dose calculations and quality control.

- ***Magnetic Resonance Imaging (MBP318):***
  This course covers the Basics of Magnetic Resonance Imaging MRI, Electronic and nuclear magnetism, Magnetic atoms, and ions. Microwave and radio frequency absorption, Magnetic resonance, Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR). Magnetic interactions, saturation, and relaxation. Computerized detection of magnetic resonance. Contrast Agents for Magnetic Resonance Imaging, Image detection and enhancement, MRI Safety, Magnetic Resonance applications in Medicine, biology, physics, and chemistry.

Sixth level:

- ***Physics of Medical Imaging (I) (MBP321):***
  This course introduces the main methods of medical imaging, namely X-ray radiography, fluoroscopy, mammography. It aims to develop an understanding of the physics principles underlying these imaging techniques and an awareness of their clinical applications. It also discusses the mathematical principle involved in image formation and processing and provides experience in their use.

- ***Computational Biophysics (MBP313):***
  This course introduces computational methods in the context of simple physical problems which cannot be solved by analytical techniques. These methods form an introduction to problem solving in the real world. Topics to be presented will be drawn from: Motion with nonlinear damping forces (introduction to ODEs); time-independent Schrodinger equation for square well and for arbitrary potentials (roots of equations, Runge-Kutta and Numerov solutions of ODEs); solution of wave equation in periodic potential, band structure (linear algebra, eigenvalues of matrix); electrostatic potential problems (solution of Laplace equation by relaxation techniques); ray tracing in optical systems and charged-particle beam lines (linear algebra); detector response by Monte Carlo techniques (integration, random numbers); the fast Fourier transform; non-linear fitting; symbolic computation.

- ***Radiation Dosimetry and Measurements (MBP323):***
  This course concerns with radiation dose measurements and calculations with different methods and technologies. Moreover, it aims to practice the quality control protocols of different medical equipment and corrections.

- ***Physics of Nuclear Medicine (MBP3242):***
  The course will cover the principle of radioisotopes used in medicine and operation of related equipment, such as formation of radionuclides, non-scintillation detectors, non-imaging scintillation detectors, imaging instrumentation, radioisotopes medical applications, nuclear medicine imaging and quality control. This course will provide a conceptual and experimental background in nuclear medicine physics sufficient to enable students to take courses that are more advanced in related fields.

- ***Medical Biophysics Laboratory (IV) (MBP325):***
  This course focuses on the dose calculation and treatment planning principles of radiotherapy in addition to application of them on selected medical cases. It concerns also with calibration and dosimetry of different radiotherapy machines.

- ***Molecular Spectroscopy (MBP326):***
  This course covers the spectroscopic methods for the study of biomacromolecules, namely, electronic, and vibrational spectroscopy, an introduction to the most complex, but most informative, technique for analyzing macromolecule and its application in identification and quantization of dynamic mobility of biomolecules in biological systems.

- ***Fundamentals of Nanotechnology in Imaging and Therapy (MBP327):***
  Nanotechnology is a multidisciplinary field. It has an innovative application in both medical imaging and therapy. This course focuses on the different applications of nanoparticles in medical and research level since nanoparticles can enhance the most of the medical imaging modalities in addition to greatly increasing the targeting and effectiveness of therapy.

- ***Applications of Biosensors in Medical Biophysics (MBP328):***
  Introduction to biosensors, biomolecules in biosensors, basics of detection methods, Biorecognition elements, Transduction principle, Surface functionalization in biosensors, Surface plasmon resonance biosensors (Biacore), Catalytic biosensors (glucosensor), Antibodies based biosensors, DNA based biosensors, Nanomaterial in biosensor technology.

- ***Bioelectronics (MBP329):***

  This course covers information about the use of dielectric relaxation spectroscopy as an important analytical tool for examining the structure and function of biological molecules, in addition to biosensors used in medical applications. It also covers interactions between electronics and biomedical science, The fundamental properties of ions in the solution, The electrical properties of cellular components: lipid bilayer and membrane proteins, Natural nanoconductors: ion channels and pumps, Energy conversion scheme in the bioelectricity generation of the cell, Biomimetic versions of natural nanoconductors, Functional bionanomachines and medical applications of bioelectronics: ECG, EEG, etc.

- ***Radiation planning (MBP330):***

This course covers provide knowledge about Units of radiation doses, emission and absorbed doses. Factors affecting isodose curve patterns in tissue-equivalent phantom, types of tissue equivalent materials, square and circles radiation fields equivalent to rectangular fields, Percentage Depth Dose backscatter, Tissue/Air ratio in tissues, Tissue/Phantom ratio in equivalent tissues. Alteration of isodose curves by patient skin contour shape, bolus and compensating filters, dose correction for tissue inhomogeneities, wedge filters for high energies, integral dose, multiple fields isodose curves (two-field and three-field plans), manual addition of isodose curves, constant SSD/FSD treatment dose calculation using Percentage Depth Dose, patient dose prescription chart, constant SAD treatment doses calculation using: Tissue/Air ratio (TAR), Tissue/Maximum ratio (TMR) and Tissue/Phantom ratio (TPR).

Seventh level:

- ***Physics of Radiation Therapy (II) (MBP411):***

This course provides knowledge on advanced radiation therapy modalities to improve the quality of radiotherapy. The course covers methods of internal and external radiotherapy, intensity modulation, as well as 3D-conformal radiotherapy. Different calculation algorithms for treatment planning, the impact of inhomogeneities, simulation and control systems. Additionally, the biological aspects of radiation therapy with models for fractional treatment are studied. Additionally, the imaging modalities used in radiotherapy.

- ***Computer Applications in Medical biophysics (MBPMt412):***
  This course covers the use of information and communication technologies in medicine and the improvement of medical mage quality using image processing software in addition to the modern application of computer in medical areas as a surgical tool.

- ***Biomaterials (MBP413):***
  This course aims to explain fundamental principles in biomedical biophysics and material science. It concerns with the structure and properties of hard materials (ceramics, metals) and soft materials (polymers, hydrogels).

- ***Physics of Medical Imaging (II) (MBP414):***
  This course aims to deliver knowledge of the theoretical principles and technology and clinical applications of imaging modalities using ionizing radiation to screen human anatomy. Demonstrate the devices instrumentations and image reconstruction of each system. The course introduces the main methods of medical imaging, namely computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and single photon emission computed tomography (SPECT). It aims to develop an understanding of the physics principles underlying these imaging techniques and an awareness of their clinical applications. It also discusses the mathematical principle involved in image formation and processing and provides experience in their use.

- ***Medical Biophysics Laboratory (V) (MBP415):***
  This course covers preparation of radiopharmaceuticals and some of their biological and medical applications. Moreover, it covers the principle of dose calibration in hot lab and usage of gamma camera in nuclear medicine.

- ***Molecular Imaging (MBP416):***
  This course covers an introduction to the role of diagnostic imaging in detecting molecules, genes, and cells in vivo. Emphasis will be in how these techniques can help study molecular mechanisms of disease in vivo. Topics include DNA/protein synthesis, transgenic mice, novel contrast agents and small animal imaging.

- ***Research project (MBP417):***
  The graduation project aims to let students develop projects that demonstrate their intellectual, technical, and creative abilities. Students develop the projects under the direction and supervision of

department members. Moreover, students gain lifelong learning skills and interface to real life applications.

- ***Medical physics Calibration and Quality Control (MBP418):***
  This course discus the QC activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardized procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity and emission factor data, and methods. Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties, should be performed upon a finalized inventory following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the QC program.

- ***Selected Topics in Medical Biophysics (MBP419):***
  This course will highlight must resent development in medical biophysics. The course introducing important concepts and the multidisciplinary nature of research, professionals, and applications in the field. The key themes are cardiovascular and circulatory health, molecular and cellular imaging for research, diagnostic imaging in humans, cancer radiotherapy, and medical images processing.

Eighth level:

- ***Field Training (MBP421):***
  The course consists of a 15-week hospital-based rotation in: Diagnostic Imaging (X-rays, CT, fluoroscopy, and Diagnostic Ultrasound), MRI, Nuclear Medicine, Radiation Therapy, Mammography, Radiation Protection, and Health Physics. The course aims to prepare the student to labor market through practicing how to dial with radioactive isotopes preparation, do treatment planning and dose rate calculations, to protect the patients and staff from radiation hazards and make dosimetry for different medical instruments to be sure from its efficiency in selected medical organization. The student will spend three months (Last-Term of his/her final year) in Specialist Hospitals where they can gain an experience in Medical physics Department within the hospital in the field of Nuclear Medicine, Radiotherapy, Medical Imaging and Radiation Protection.

- ***Research project (MBP422):***
  The graduation project aims to let students develop projects that demonstrate their intellectual, technical, and creative abilities. Students develop the projects under the direction and supervision of

department members. Moreover, students gain lifelong learning skills and interface to real life applications.

- ***Ethics in Medical Biophysics (MBP423):***

The main purpose of the course to understand ethics and ethical decision making in clinical practice and research, develop problem-solving skills in applying ethical standards, and research methods. Understand the basics of statistical reasoning and inferential methods, as well as statistical modeling and its limitations. This course covers the methods of collecting data in addition to interpreting and communicating the results of statistical analysis. In addition to write and present a short medical physics research paper.

- ***Computational Radiation Transport (MBP424):***

This course provides an in-depth review of modern computational techniques used for solving the linear boltzmann equation, with specific applications to neutron and photon radiation transport problems. Topics to be covered include: an introduction to the physical processes that govern radiation transport through materials, monte carlo methods for the simulation of radiation transport, a first-principles derivation of the boltzmann radiation transport equation for multiplying and non-multiplying systems, the multi-group, diffusion, and discrete ordinates approximations to the transport equation, expansion of the scattering kernel in legendre polynomials, and numerical methods for approximating solutions to the transport equation. In addition, the course will review many commonly used numerical methods for solving integral and differential equations, including finite differencing, numerical quadrature, harmonic analysis, and the power method for solving eigenvalue problems. Topics covered in the class will be reinforced with weekly programming exercises designed to illustrate the different methods for solving the boltzmann radiation transport equation and demonstrate how these methods can be used to solve realistic problems related to nuclear reactor and radiation shielding analysis. The course will also places a strong emphasis on formal quality assurance methods (and best-practices) for the development, verification, and validation of scientific computer codes intended for use in engineering design calculations of record.

- ***Programming Methods for Radiotherapy treatment planning (MBP 425):***

This course aims to uses a computer program to assist in comparing dose distribution for proposed treatment plans. Each time a patient is treated with any arrangement more complicated than a pair of parallel opposing fields, tentative ideas are developed for several multifield arrangements

J. General rules of the program:

The program follows the general regulations for the bachelor's degree in the credit-hour system, at the Faculty of Science, Cairo University, and the subsequent amendments.

K. Program Admission Requirements:

- The student must be nominated as a candidate for the faculty of science from the universities' coordination office.
- Student should pass the personal interview.
- The trade-off between the students is based on the highest grades in biology and physics.

L. Graduation Requirements:

Students perform training for a period of 6 weeks, after the sixth level, in Cairo University hospitals (such as Kasr Al-Ainy and the Oncology Institute). An agreement is also made with the Institute of Eye Diseases, the Laser Institute, the Energy Authority, and some diagnostic and treatment centers) to provide various training places in different fields .

M. Teaching Strategies and Program Assessment Methods:

Code #	Program Learning Outcomes	Teaching Program Strategies	Program Assessment Method
1.0 Knowledge			
	Summary description of the knowledge to be acquired and on completing this program, students will be able to: a1. Acquire the major aspects of nature and subject of medical biophysics and the application of physics to medicine. a2. Recognize the human body physiology and the application of physical concepts of body cell membranes, bone mechanics, and the principles of laser and its application in medicine. a3. Describe Bioinformatics to know how to analysis data which is used to diagnose with the aid of different medical devices such as gamma camera,	- *Demonstrating the basic information and principles through medical training.* - *Start each medical training practice by*	*Quizzes - Oral and written exam.*

	utlrasnoic imaging and X- ray, nuclear magnetic resonance machines. a4. Define different quantitative, mathematical science and physical tools analyze problems and list some foundations of systems theory to solve and analysis different problems. a5. Recognize the nature, properties, dosimetery of radiation and basics of radiation protection and also medical effects of ionizing and non-ionizing radiation. a6. Outline the principles of physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical biophysics	*general idea and the benefit of it.* - *Brainstorming sessions.* - *Lecturing-interactive discussion.* - *Self learning.*	
2.0 Cognitive Skills			
	Summary description of the Cognitive Skills to be acquired and on completing this program, students will be able to: b1. Reorganize mathematical and physical formulas and demonstrate skills of critical thinking and analytical reasoning to solve problems in medical biophysics and related fields of studies. b2. Interpret the data obtained from testing, diagnostic instruments such as MRI, X-rays, ultrasonic images, CT images and gamma camera images. b3. Analyze and apply the mathematical expressions in evaluating and understanding of essential facts, concepts, principles, and theories of medical biophysics. b4. Formulate and test hypotheses using appropriate experimental design and	- *Solving problems.* - *Dialogues and discussions.* - *Lecture.* - *Searchingon the internet.* - *Experimental work and its outcomes.* - *Projects.* - *Workshops.* - *Web-based activities.*	- *Quizzes- Assignments - Exams.* - *Report - Oral presentation.* - *Observation – Test - Report.* - *Analytical reports* - *Case studies* - *Project report*

	analysis of data (Computer simulation) and integrate IT-based solutions into the user environment effectively.	- *Individual and group assignments.* - *Encourage the student to look for the information in different references.*	
3.0 Interpersonal Skills & Responsibility			
	Summary description of the Interpersonal Skills, and Responsibility to be acquired and on completing this program students will be able to: c1. Analyze and evaluate information by using computational tools to interpret experimental data relevant to medical biophysics by using packages from different theoretical and experimental resources, and perspectives. c2. Operate some medical instruments such as that used for the diagnosis of different diseases in medical centers and demonstrate competency in laboratory techniques and safety. c3. Use scientific literature effectively and prepare technical reports that for individual student or making a group of researchers. c4. Justify ethical, social and legal responsibilities concerning Medical biophysics.	- *Project - Lab work.* - *Group and interactive discussion.* - *Project - Lab work - Field visit.* - *Interactive discussion.* - *Lecture - Research activities brain storming.* - *Case studies.*	- *Observation – Assignment.* - *Reports – Survey.*
4.0 Communication, Information Technology, Numerical			
	Summary description of the Communication, Information Technology and Numerical Skills to be acquired and on completing this program students will be able to:		

	d1. Illustrate and employ the processes of scientific inquiry and research methods through use effective information and communications technology (IT) tools and use the basic software, to ensure globally understand of medical biophysics issues. d2. Demonstrate scientific concepts and analytical argument, in a clear and organized way, verbally and in writing. d3. Implement all kinds of relevant information in medical biophysics with local and internationally accessible libraries, information database, and electronic data and use that information in problem solving activities. d4. Work independently and demonstrate the ability to manage time and to work as a part of a team and learn independently with open– mindedness to learn how solve the daily life problems.	- *Small group discussion.* - *Small group work brainstorming.* - *Project - Lab work – Interactive discussion.*	- *Individual presentation.* - *Group reports.* - *Exams - Individual presentation.* - *Group presentation.* - *Case studies.* - *Exams, Analytical reports.*

N. Evaluation Methods:

- Evaluation of field training. The student obtains a certificate stating whether he has passed the summer training or not.
- Evaluation of the Research project evaluates the research submitted by the student in addition to an oral evaluation during a presentation that he performs in front of the department's graduation projects discussion committee.

Method	Mark Percent
Written Exam	60 %
Oral Exam	10 %
Practical Exam	20 %
Periodic Exams	10 %
Total	100 %

Biophysics Department

جامعة القاهرة

Program Coordinator: Professor in Specialty

Head of Biophysics Department: Prof. Dr. Reem H. Elgebaly

Dean of Faculty of Science: Prof. Dr. Ahmed A. Elsherif