



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S
Cairo University



جامعة القاهرة

NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES N.I.L.E.S.



CAIRO UNIVERSITY

2016



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S
Cairo University



جامعة القاهرة

**NATIONAL INSTITUTE
OF
LASER ENHANCED SCIENCES
N.I.L.E.S.**

CAIRO UNIVERSITY

2016



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S

Cairo University



جامعة القاهرة

اللائحة الداخلية للدراسات العليا (٢٠١٦م)

المعهد القومى لعلوم الليزر

Contents

Item	Page No.
▪ Department of Laser Sciences and Interactions (LSI)	1
▪ Department of Medical Applications of Lasers (MAL)	9
▪ Department of Laser Applications in Metrology, Photochemistry and Agriculture (LAMPA)	29
▪ Department of Engineering Applications of Lasers (EAL)	45



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S
Cairo University



جامعة القاهرة

اللائحة الداخلية للدراسات العليا (٢٠١٦م)

المعهد القومي لعلوم الليزر

Department of Laser Sciences and Interactions (LSI)



Department of Laser Sciences and Interactions (LSI)

Department of Laser Sciences and Interactions (LSI) offers the candidates the opportunity to study for the Diploma, M.Sc. Degree and Ph.D. Degree in one of the following specialties:-

1. Laser Interaction with Matter (LIM)
2. Laser Systems (LS)

I. Diploma:-

A) General Main Courses (7 Cr. Hrs.) for both specialties

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LSI 501	Laser Safety	1	1		
LSI 502	Optical Instruments	2	2		
LSI 503	Numerical and Computational Methods	2	1	2	
LSI 504	Laser Lab I	2			4

B) Special Main Courses (17 Cr. Hrs.) for the specialty of Laser Interaction with Matter (LIM)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LIM 501	Fundamentals of Laser Physics	4	3		2
LIM 502	Laser Interaction with Matter	3	3		
LIM 503	Optoelectronics	3	3		
LIM 504	Diagnostic Techniques	4	3		2
LIM 505	Selected Topics and Project	3	2		2

C) Special Main Courses (17 Cr. Hrs.) for the specialty of Laser Systems (LS)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LS 501	Laser Physics	3	3		
LS 502	Fiber Optics and Guided-Wave Optics	2	2		
LS 503	Selected Topics	2	2		
LS 504	Applied Project	2	1		2
LS 505	Optoelectronics	2	2		
LS 506	Spectroscopy	1	1		
LS 507	Optical Diagnostics Techniques	2	2		
LS 508	Optical Systems and Materials	1	1		
LS 509	Vacuum Principles	2	2		



LSI 501 Laser Safety (1 Cr. Hr.)

This course covers laser characteristics and classifications; types of hazards and safety rules.

LSI 502 Optical Instruments (2 Cr. Hrs.)

Introduction to optical spectroscopy, spectrographs and monochromators, spectrometer: basic properties, prism spectrometer, and grating spectrometer, spectral resolving power, interferometers: Michelson, Mach-Zehnder, etc, light sources: lamps and lasers. Basic parameters and types of detectors. Optimization S/N ratio.

LSI 503 Numerical and Computational Methods (2 Cr. Hrs.)

Introduction to computer interfacing. Numerical and computational techniques. Computer languages used in science.

LSI 504 Laser Lab I (2 Cr. Hrs.)

The lab covers different experiments using lasers in different applications such as polarization, Fabry Perot Interferometer, Laser Diodes....etc.

LIM 501 Fundamentals of Laser Physics (4 Cr. Hrs.)

The course provides the physical principles of laser operation and design. A background of wave and quantum properties of light such as coherence, energy levels, emission linewidth and stimulated emission are discussed. The concepts of population inversion, gain, saturation intensity, cavity modes, Gaussian beam and laser resonator, Q-switched and mode locked lasers are then included. The course ends with studying some known examples of lasers such as gas, solid-state, liquid, and semiconductor laser.

LIM 502 Laser Interaction with Matter (3 Cr. Hrs.)

Overall aims of course: To introduce the characteristics of laser beam, its quantum mechanical interactions with matter and the mechanisms of each interaction. Finally to illustrate how each mechanism can be utilized for material processing or for diagnosis, giving examples for the practical applications of each mechanism of interaction of laser with matter in all systems, industrial applications, biological applications as well as medical applications.

LIM 503 Optoelectronics (3 Cr. Hrs.)

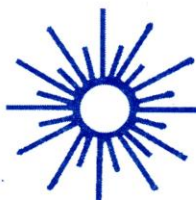
This course introduces fundamental optical properties such as quantum theory of radiation, absorption processes, radiative processes, nonradiative processes, photoluminescence of bulk semiconductors, semiconductor heterojunctions, quantumwells, and superlattices. Applications of these materials and properties in optoelectronic devices such as lasers, photodetectors, and solar cells will be also covered.

LIM 504 Diagnostic Techniques (4 Cr. Hrs.)

Diagnostic techniques are essential for all aspects of scientific measurements. Light detection, wavelength, power and time of laser are important quantities to be measured. Several techniques devoted to study the previous physical quantity must be investigated and the components of each technique are also studied in details. It's of importance to state the source of noise for each technique.

LIM 505 Selected Topics and Project (3 Cr. Hrs.)

The student selects a topic from a list given by the Department Council at the start of each semester. The project should address practical problems related to a technological application.



LS 501 Laser Physics (3 Cr. Hrs.)

Physical principles of laser operation and design are presented. A background of waves and quantum properties of light are discussed. The concepts of population inversion, gain, cavity modes, laser resonator. Some well known types of lasers such as gas, solid-state, liquid, and semiconductor laser.

LS 502 Fiber Optics and Guided-Wave Optics (2 Cr. Hrs.)

Theory and principle of fiber optics, classification of fiber types and its uses, attenuation and dispersion, waveguides: Planer-mirror, planer dielectric, 2D and optical coupling.

LS 503 Selected Topics (2 Cr. Hrs.)

The student selects a topic from a list given by the Department Council at the start of each semester.

LS 504 Applied Project (2 Cr. Hrs.)

Students select their topics according to their background and field of interest and meet the project supervisor for discussion. A project report is submitted at the end of semester.

LS 505 Optoelectronics (2 Cr. Hrs.)

Principles of optoelectronic applications such as light-emitting diodes, laser diodes and modulators: Electro optic devices, Acoustic-optic devices, Magneto optic devices.

LS 506 Spectroscopy (1 Cr. Hr.)

Absorption and emission spectrum, transition probabilities, widths and profiles of spectral Lines.

LS 507 Optical Diagnostics Techniques (2 Cr. Hrs.)

Time resolved laser spectroscopy. Optical microscopic techniques, coherent spectroscopy, pump probe and other spectroscopic techniques.

LS 508 Optical Systems and Materials (1 Cr. Hr.)

Properties of the most common types optical materials, which are commonly used for optical components and systems such as glass, crystals, and plastics and their dependence on light wavelength are described.

LS 509 Vacuum Principles (2 Cr. Hrs.)

Introduction to low and high vacuum systems and equipments, vacuum chambers, vacuum gauges, Rotary pumps, diffusion pumps, turbo molecular pumps.

**II. M.Sc. Degree:-****A) General Main Courses (3 Cr. Hrs.) for both specialties**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LSI 601	Nonlinear Optics	2	2		
LSI 602	Laser Lab II	1			2

B) Special Main Courses (9 Cr. Hrs.) for the specialty of Laser Interaction with Matter (LIM)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LIM 601	Laser Physics	3	3		
LIM 602	Laser Plasma Interaction	2	2		
LIM 603	Optical Diagnostics and Imaging	2	2		
LIM 604	Selected Topics	2	2		

C) Special Main Courses (9 Cr. Hrs.) for the specialty of Laser Systems (LS)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LS 601	Advanced Laser Physics	2	2		
LS 602	Gas Discharge and Plasma Physics	2	2		
LS 603	Quantum Electronics	2	2		
LS 604	Electronics	2	1		2
LS 605	Selected Topics	1	1		

LSI 601 Nonlinear Optics (2 Cr. Hrs.)

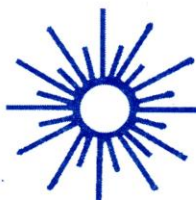
Introduction into the basic nonlinear-optical phenomena, discussion some of the most well known breakthroughs in nonlinear optics such as second and third order susceptibility and polarization, phase matching and quasi phase matching, harmonics and sum frequency generation.

LSI 602 Laser Lab II (1 Cr. Hr.)

A guided tour is introduced to students to the research laboratories in the department to familiarize student with current experiments in the different research groups.

LIM 601 Laser Physics (3 Cr. Hrs.)

Laser oscillations and amplification, pulses generation mechanisms, Q-switching and mode-locking principles and mechanisms, electro and magnetic optic modulators, Laser resonators and Gaussian beams, picoseconds and femtosecond lasers, free electron lasers, fiber laser amplifier, parametric amplification, photonic switching and computation. Some applications of lasers.



LIM 602 Laser Plasma Interaction (2 Cr. Hrs.)

Introduction to radiation of gases and plasmas. Fundamental parameters used to describe plasmas. Interaction of electromagnetic waves with particles in plasmas. Theory of light scattering by plasma. Basic principles of different lasers interaction with plasma, Laser propagation through plasmas (Thomson Scattering, Laser induced fluorescence, laser transmission and interference through plasma), Laser heat plasma. Laser drive plasma.

LIM 603 Optical Diagnostics and Imaging (2 Cr. Hrs.)

The aim of this course is to study in detail of the optical diagnostics techniques including imaging. The basics of spectroscopy techniques are explained briefly. Coherent anti-Stokes Raman scattering (CARS) spectroscopy, time resolved spectroscopy and infrared Fourier transform spectroscopy. Other techniques of adequate importance may be added to the course content.

LIM 604 Selected Topics (2 Cr. Hrs.)

The student selects a topic from a list given by the Department Council at the start of each semester.

LS 601 Advanced Laser Physics (2 Cr. Hrs.)

Generation of ultrafast laser pulses and characteristics, Laser oscillation and amplification, pulses generation mechanisms, Q-switching and mode-locking principles mechanisms, electro and magnetic optic modulators, picoseconds and femto-second lasers, free electron lasers, fiber laser amplifier. Ultrafast pulses detection systems, Hole burning, Ultrafast spectroscopy and dynamics.

LS 602 Gas Discharge and Plasma Physics (2 Cr. Hrs.)

Fundamental processes in plasma. Excitation processes in gas discharge processes. Coulomb collisions, Plasma Descriptions. Plasma equilibrium and stability. Kinetic theory. Nonlinear effects on plasma and quantum plasma. Solid state plasma, Plasma thrusters. Low and high temperature plasma. Theory of plasma diagnostics.

LS 603 Quantum Electronics (2 Cr. Hrs.)

Basic theorem, postulates and Matrix formulation of quantum mechanics. Theory of Interaction of radiation with atomic systems, Quantization of the radiation field, Coupled Wave Equations for Generating New Frequencies.

LS 604 Electronics (2 Cr. Hrs.)

Analog and digital electronics, transistors types, integrated circuit, Boolean algebra, and gates.

LS 605 Selected Topics (1 Cr. Hr.)

The student selects a topic from a list given by the Department Council at the start of each semester.

**III. Ph.D. Degree:-****A) General Main Course (3 Cr. Hrs.) for both specialties**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LSI 701	Advanced Semiconductor Laser Physics	3	3		

B) Special Elective Courses (9 Cr. Hrs.) for the specialty of Laser Interaction with Matter (LIM)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LIM 701	Nanotechnology	3	3		
LIM 702	Advanced Diagnostic Techniques	3	3		
LIM 703	Fast and Ultrafast Phenomena	3	3		
LIM 704	Advanced Laser Plasma Interactions	3	3		
LIM 705	Selected Topics	3	3		

C) Special Elective Courses (9 Cr. Hrs.) for the specialty of Laser Systems (LS)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LS 701	Advanced Nonlinear Optics	3	3		
LS 702	Short and Ultra Short Pulsed Lasers	3	3		
LS 703	Photonic Materials	3	3		
LS 704	Group Theory in Physics	3	3		
LS 705	Selected Topics	3	3		

LSI 701 Advanced Semiconductor Laser Physics (3 Cr. Hrs.)

Introduction to semiconductor lasers, threshold condition and input output power dependence, wave guiding in hetero-structure, different structures in semiconductor laser devices such as high power single mode lasers, distributed brad reflector laser.

LIM 701 Nanotechnology (3 Cr. Hrs.)

History of nanotechnology and overview of nanomaterials, Nanocharacterization methods, Fabrication and Synthesis of nanomaterials, Carbon nanotubes, Inorganic Nanowire / nanotubes, Nanoparticles, Nanocomposites, Mechanics of nanoscale materials, Nanoscale properties (electrical, optical, chemical), Nanotechnology for Health care and medicine, Nanotechnology for energy Harvesting, storage & conversion, Nanotechnology for electro-optic-mechanical devices.

LIM 702 Advanced Diagnostic Techniques (3 Cr. Hr.)

Laser scanning microscopy and applications, two photon absorption microscopy and applications, second harmonic generation microscopy, and applications, time resolved spectroscopy and applications, Inductively coupled Plasma (ICP) mass spectroscopy and applications, Atomic force microscopy and applications. Fiber optics.



LIM 703 Fast and Ultrafast Phenomena (3 Cr. Hrs.)

Laser Applications and ultra fast laser pulses, Fiber optics (Er-doped fiber-optics laser amplifier), fast and ultrafast phenomena diagnosis via short and ultra short laser pulse, types of fast and ultra fast phenomena relation to semiconductors and detectors. Photon interactions, electron-photon- phonon interactions, semiconductors- photon source in the pico- and femto-second regions. Life time measurements experimentally.

LIM 704 Advanced Laser Plasma Interactions (3 Cr. Hrs.)

The basic theory of the interaction of intense electromagnetic radiation fields with matter, Applications of intense fields in plasma: inertial fusion, wakefield accelerators, and advanced radiation sources. State-of-the-art diagnostic tools and experimental techniques used to study laser-plasma interactions. Simulation tools for modeling these interactions with a focus on current research trends.

LIM 705 Selected Topics (3 Cr. Hrs.)

The student selects a topic from a list given by the Department Council at the start of each semester.

LS 701 Advanced Nonlinear Optics (3 Cr. Hrs.)

Frequency conversion, Electro-Optic, Photorefractive effects, Optical switching, Phase conjugation, Spontaneous and Stimulated light Scattering and Soliton generation in optical fibers, Stimulated Brillouin Scattering, Stimulated Rayleigh Scattering, Stimulated Raman Scattering Optically Induced Damage and Multi-photon absorption.

LS 702 Short and Ultra Short Pulsed Lasers (3 Cr. Hrs.)

Definition and Principle, Generation of Ultra short pulses, mode locking, compression technique, selection of optical components. Generation of ultra short pulses using doped optical fibers, atto second optical pulse generation. Detection of ultra pulses, temporal measurements (cross correlation and auto correlation), spectral profile, frequency resolved optical grating (frog) technique, ultra short pulses spectroscopy. Ultra short laser pulse propagation. Tera-hertz generation.

LS 703 Photonic Materials (3 Cr. Hrs.)

Photonics crystals in one-, two- and three- dimensions. 1D: Planar dielectric multilayer films, planar diffraction grating, fiber Bragg grating, 2D: Planar films with 2D patterns, Holey fibers, 3D: Photonics crystals structures with a photonic band gap Bloch waves. Evanescent waves, mode expansions of electromagnetic waves in Bloch waves. Crystal defects.

LS 704 Group Theory in Physics (3 Cr. Hrs.)

Introduction to group theory, GT in crystals, GT in atoms and molecules.

LS 705 Selected Topics (3 Cr. Hrs.)

The student selects a topic from a list given by the Department Council at the start of each semester.



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S
Cairo University



جامعة القاهرة

اللائحة الداخلية للدراسات العليا (٢٠١٦م)

المعهد القومي لعلوم الليزر

Department of Medical Applications of Lasers (MAL)



Department of Medical Applications of Lasers (MAL)

Department of Medical Applications of Lasers (MAL) offers the candidates the opportunity to study for the Diploma, M.Sc. Degree and Ph.D. Degree in one of the following specialties:-

1. Laser Applications in Surgery
2. Laser Applications in Dermatology
3. Laser Applications in Ophthalmology
4. Laser Applications in ENT
5. Laser Applications in Gynecology
6. Laser Applications in Pediatrics
7. Laser Applications in Physical Medicine, Rheumatology and Rehabilitation
8. Laser Applications in Oral and Dental Medicine
9. Laser Applications in Pharmaceutical Sciences
10. Laser Applications in Physiotherapy

I. Diploma:-

A) General Main Courses (9 Cr. Hrs.) for all specialties

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
MAL 501	Laser Physics in Medicine	2	2		
MAL 502	Laser Safety in Medicine	2	2		
MAL 503	Photomedicine I	2	2		
MAL 504	General Laser Applications in Medical and Surgical Studies	3	2	2	

B) General Elective Courses (4 Cr. Hrs.) for all specialties

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
MAL 505	Communication and Information Technology	2	1	2	
MAL 506	Medical Ethics	2	2		
MAL 507	Instrumentation and Measurement Science	2	2		
MAL 508	Scientific Thinking	2	2		
MAL 509	Scientific Writing	2	2		



C) Special Main Courses (11 Cr. Hrs.) for each specialty

Specialty	Course		Credit Hours (Cr. Hrs.)	Contact Hours		
	Code	Course Name		Lecture	Exercise	Practical
Laser Applications in Surgery	MAL 510	Laser Applications in Surgery I	4	2	4	
	MAL 511	Practical Laser Applications in Surgery	3			6
	MAL 512	Applied Project in Laser Applications in Surgery	4	2		4
Laser Applications in Dermatology	MAL 513	Laser Applications in Dermatology I	4	2	4	
	MAL 514	Practical Laser Applications in Dermatology	3			6
	MAL 515	Applied Project in Laser Applications in Dermatology	4	2		4
Laser Applications in Ophthalmology	MAL 516	Laser Applications in Ophthalmology I	4	2	4	
	MAL 517	Practical Laser Applications in Ophthalmology	3			6
	MAL 518	Applied Project in Laser Applications in Ophthalmology	4	2		4
Laser Applications in ENT	MAL 519	Laser Applications in ENT I	4	2	4	
	MAL 520	Practical Laser Applications in ENT	3			6
	MAL 521	Applied Project in Laser Applications in ENT	4	2		4
Laser Applications in Gynecology	MAL 522	Laser Applications in Gynecology I	4	2	4	
	MAL 523	Practical Laser Applications in Gynecology	3			6
	MAL 524	Applied Project in Laser Applications in Gynecology	4	2		4
Laser Applications in Pediatrics	MAL 525	Laser Applications in Pediatrics I	4	2	4	
	MAL 526	Practical Laser Applications in Pediatrics	3			6
	MAL 527	Applied Project in Laser Applications in Pediatrics	4	2		4



Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	MAL 528	Laser Applications in Physical Medicine, Rheumatology and Rehabilitation I	4	2	4	
	MAL 529	Practical Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	3			6
	MAL 530	Applied Project in Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	4	2		4
Laser Applications in Oral and Dental Medicine	MAL 531	Laser Applications in Oral and Dental Medicine I	4	2	4	
	MAL 532	Practical Laser Applications in Oral and Dental Medicine	3			6
	MAL 533	Applied Project in Laser Applications in Oral and Dental Medicine	4	2		4
Laser Applications in Pharmaceutical Sciences	MAL 534	Laser Applications in Pharmaceutical Sciences I	4	2	4	
	MAL 535	Practical Laser Applications in Pharmaceutical Sciences	3			6
	MAL 536	Applied Project in Laser Applications in Pharmaceutical Sciences	4	2		4
Laser Applications in Physiotherapy	MAL 537	Laser Applications in Physiotherapy I	4	2	4	
	MAL 538	Practical Laser Applications in Physiotherapy	3			6
	MAL 539	Applied Project in Laser Applications in Physiotherapy	4	2		4

MAL 501 Laser Physics in Medicine (2 Cr. Hrs.)

Candidates will study fundamentals of lasers and basic laser principals. Structure, conformation of biological molecules with structure-function relationships, biomechanics, biocompatibility and tissue damage. They will study the non-ionizing electromagnetic radiation and its tissue absorption and safety. They will study the biochemical measuring techniques using light, essential optical principles, fundamentals of light propagation in biological tissues, fundamentals of photothermal effects of laser, fiber optics and waveguides in medicine.

MAL 502 Laser Safety in Medicine (2 Cr. Hrs.)

In this course they will study Laser radiation of sufficient intensity and exposure time can cause irreversible damage to the skin and eye. The use of lasers in clinics and labs showed be according to international safety standards. Accidents or damage process is generally related to exposure time and wavelength at near UV to far IR.



MAL 503 Photomedicine I (2 Cr. Hrs.)

This Course provides a basic level of education on photomedicine and photobiology. Light is electromagnetic waves. Laser and light tissue interaction. Light absorbing chromophore. Photoimmunological responses towards light. Photosensitization: photochemotherapeutic sensitization, photodynamic sensitization, photosensitizers and photothermal sensitization.

MAL 504 General Laser Applications in Medical and Surgical Studies (3 Cr. Hrs.)

By the end of this course, the student will be able to know the general use of laser in the different medical specialties and understand the indication, contraindications, rational of treatment, complications and surgical prognosis. Candidate will also be able to differentiate theoretically and practically between different types of lasers that are usually used in each indication. The student will be also recognize the famous operations and procedure that could be treated or used by such lasers. This course covers the general application of laser in Dermatology, Surgery, Pediatrics, ENT, Gynecology, Ophthalmology, Physical medicine and physiotherapy, Oral and Dental Medicine and Pharmaceuticals and photobiology.

MAL 505 Communication and Information Technology (2 Cr. Hrs.)

Computer science: Windows, Office, Computer language, Internet with emphasis on technology and practice of medicine and use of computers for research, collaboration, and communication in medicine, and use of computers as clinical tools. Familiarize students with computers as educational tools and as tools for lifelong learning, Use of windows, office, computer language and internet and its various applications in medicine

MAL 506 Medical Ethics (2 Cr. Hrs.)

This course is aimed at providing a general understanding of the ethical questions posed by maintaining and improving public health. It addresses ethical issues raised by clinical research and medical practice, as well as any impact those issues may have on the community or global level.

MAL 507 Instrumentation and Measurement Science (2 Cr. Hrs.)

This course is designed to prepare the student for employment in research and development focusing on technical and scientific instruments or processes. It is intended to give a basic background about the essential instrumental techniques and their applications in biomedical research, for candidates managing and working in laboratories needed for their biomedical research and studies and to insure lab quality control. The basic principles of the essential techniques like: Spectroscopic analysis; UV/Vis, IR, Material separation; HPLC, AA and CS, electrophysiology, bacteriology, and electro analytical techniques will be covered. This will include discussion of the theory of each procedure, applications and method of measurements. A key objective of this course is to introduce, refresh and provide hands-on laboratory experience. Attendees will be trained in the lab: hands-on experience of the techniques exposed to during the lectures.

MAL 508 Scientific Thinking (2 Cr. Hrs.)

Introduction to the scientific method and the various attributes of this approach to knowledge. Structure and design of scientific experiments. Birth of modern science: historical development, examples. What is science? How can we differentiate between science and pseudoscience. Science view of life and the universe. Science, value of ethics.

MAL 509 Scientific Writing (2 Cr. Hrs.)

Choosing a research problem, using library, first step in treating data, writing paper, making the paper interesting, correcting the type written copy, good form and using tables and illustration, prepublication review, Bibliography, Index.



MAL 510 Laser Applications in Surgery I (4 Cr. Hrs.)

The goal of this course is to enhance the student understanding and knowledge of the applications of laser technology in Surgery. This Course provides a level of didactic and exercises to be satisfactorily on the use of laser in Surgery with knowledge of diagnosis and possible treatment alternatives, indication, and contraindications. Sound knowledge of treatment objective, laser operating parameters, management of complications, surgical prognosis, post-operative management and follow-up care are also focused on.

MAL 511 Practical Laser Applications in Surgery (3 Cr. Hrs.)

This Course provides an introductory basic level of practical experience to be satisfactorily on the use of medical laser equipment, and hands on laser with different fiber optics and free beam lasers, used in Surgery. Use of laser setting and adjustment of laser parameters, different delivery systems, laboratory for endoscopy, surgical microscopy and colposcopy, as well as, laser cutting of tissues, laser tissue coagulation, welding and soldering are included.

MAL 512 Applied Project in Laser Applications in Surgery (4 Cr. Hrs.)

The students meet their project institute advisor for project follow-up. It is a capstone project. Seminar and review of literature in a topic related to Surgery. Project Evaluation and grades are based on seminar presentation, report and the final product.

MAL 513 Laser Applications in Dermatology I (4 Cr. Hrs.)

The goal of this course is to enhance student to know laser tissue interaction and different lasers that treat skin disease that respond to laser therapy. Also nature of these diseases and comparing results of laser therapy with traditional lines of treatment, in addition to side effects and complication that might occur and how to avoid and manage them.

MAL 514 Practical Laser Applications in Dermatology (3 Cr. Hrs.)

This Course provides an introductory basic level of laboratory education to be satisfactorily on the use of medical laser equipment, and hands on laser with different fiber optics and free beam lasers, used in Dermatology. Use of laser through different delivery systems, Practical Knowledge of setting and adjusting the parameters of laser in Dermatology.

MAL 515 Applied Project in Laser Applications in Dermatology (4 Cr. Hrs.)

It teaches the student how to write project or research in laser applications in dermatology, how to search different scientific websites, how to design the project to reach a final conclusion or suggestions to improve laser treatment.

MAL 516 Laser Applications in Ophthalmology I (4 Cr. Hrs.)

It is project and review of literature in certain and new topic related to laser application in ophthalmology and to evaluate the students basing on presentation, report and final product.

MAL 517 Practical Laser Applications in Ophthalmology (3 Cr. Hrs.)

The goal of this course is to provide basic level of laboratory education to be satisfactorily on use of medical laser equipment in ophthalmology and knowing laser with different fiberoptics, also the use of laser through different delivery systems and the practical knowledge of different parameters of laser in ophthalmology.

MAL 518 Applied Project in Laser Applications in Ophthalmology (4 Cr. Hrs.)

It is a capstone project. Seminar and review of literature in a topic related to Laser Applications in Ophthalmology. Evaluation and grades are based on seminar presentation, report and the final product.



MAL 519 Laser Applications in ENT I (4 Cr. Hrs.)

The goal of the course is to enhance student understanding and knowledge of the application of laser technology in Otolaryngology. By the end of this course, the student will be able understand, practice and calculate the dose of every laser used in all indication in ENT. It will also provide an advanced level of theoretical, laboratory, and clinical exercises to be satisfactorily on the use of laser in the ENT with knowledge of diagnosis and possible treatment alternatives, indication, contraindications and laser safety. Sound knowledge of treatment objective, laser operating parameters including wavelength, power, repetition rate (if applicable), beam diameter (spot size) exposure duration and treatment sequence, management of complications, surgical prognosis, post-operative complications.

MAL 520 Practical Laser Applications in ENT (3 Cr. Hrs.)

This Course provides an introductory basic level of laboratory education to be satisfactorily on the use of ENT laser equipment, and hands on laser with different fiber optics and free beam lasers, used in ENT. Use of laser through different delivery systems, including Lab for endoscopy and surgical microscopy micromanipulator and back stop. Laser cutting of tissue (including continuous wave, pulsed), Laser tissue coagulation, welding and soldering. Practical Knowledge of setting and adjusting the parameters of laser in ENT

MAL 521 Applied Project in Laser Applications in ENT (4 Cr. Hrs.)

It is a capstone project. Seminar and review of literature in a topic related to Laser Applications in ENT. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 522 Laser Applications in Gynecology I (4 Cr. Hrs.)

This course is designed to introduce the student to laser and its applications in Gynecology. This includes different types of lasers used in Gynecology and factors affecting laser interaction with the tissues methods of laser delivery, comparison between laser and other energy sources in gynecological applications.

MAL 523 Practical Laser Applications in Gynecology (3 Cr. Hrs.)

This Course provides an introductory basic level of laboratory education to be satisfactorily on the use of Gynecology laser equipment. Designed to offer broad exposure and training in the field of laser in Gynecological disorders and applications. It gives a solid foundation for proper selection of different types of users and the parameters required to achieve desired laser tissue interaction. It introduces the hands on application of different delivery systems in the field of Gynecology.

MAL 524 Applied Project in Laser Applications in Gynecology (4 Cr. Hrs.)

A research project related to laser application in the field of Gynecology. This project is a review of literature in which the student will define of research related to laser in Gynecology and conduct a literature review related to the topic of research and prepare a manuscript suitable for publication and presentation.

MAL 525 Laser Applications in Pediatrics I (4 Cr. Hrs.)

This course provides an insight on the applications of laser technology in the field of Pediatrics. This course aims to provide basic aspects of genetics and pediatric diseases through didactic and practical exercises together with advanced knowledge of laser operating parameters and the use of light emitting diode phototherapy in different pediatric diseases, considering the latest knowledge and techniques in laser applications.



MAL 526 Practical Laser Applications in Pediatrics (3 Cr. Hrs.)

This is an introduction for the basics of using different lasers in Pediatrics, including types, names, mood of action of all possible laser devices used in Pediatrics, and the indications, contraindications and the side effects. There are demo applications for minor training.

MAL 527 Applied Project in Laser Applications in Pediatrics (4 Cr. Hrs.)

This is a special project related to Pediatrics based on the candidate's choice. At first all candidates make search for the up-to-date research topics in Pediatrics. According to topics candidates will be divided into small groups which are related to the same topics. During the course the students will be guided and advised in the method of research and how to write the project. They will be evaluated in two levels, in the group level and individual level with presentation for each student.

MAL 528 Laser Applications in Physical Medicine, Rheumatology and Rehabilitation I (4 Cr. Hrs.)

The goal of the this course is to enhance student understanding and knowledge of the application of laser technology in Physical medicine This course provides an introduction to the basics of laser and the practical education on its general use in Physical medicine and Rehabilitation. This course provides an advanced level of didactic, and exercises to be satisfactorily on the use of laser in the Physical medicine with knowledge of diagnosis and possible treatment alternatives, indication, contraindications and informed consent. Sound knowledge of treatment objective, laser operating parameters management of complications, prognosis and follow-up care.

MAL 529 Practical Laser Applications in Physical Medicine, Rheumatology and Rehabilitation (3 Cr. Hrs.)

This Course provides an introductory basic level of laboratory education to be satisfactorily on the use of medical laser equipment, and hands on laser with different delivery systems and free beam lasers, used in Physical Medicine and Rehabilitation. Use of laser through, practical knowledge of setting and adjusting laser parameters in Physical Medicine

MAL 530 Applied Project in Laser Applications in Physical Medicine, Rheumatology and Rehabilitation (4 Cr. Hrs.)

It is a capstone project. Seminar and review of literature in a topic related to laser applications in Physical Medicine, Rheumatology and Rehabilitation. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 531 Laser Applications in Oral and Dental Medicine I (4 Cr. Hrs.)

The goal of this course is to enhance student understanding and knowledge of the application of laser technology in Oral and Dental medicine. This course provides an advanced level of didactic, laboratory, and clinical exercises to be satisfactorily on the use of laser in oral surgery, periodontology, different restorative dental practice, as well as the clinical application of the recent research outcome in the field of dental laser applications, knowledge of treatment objective, and laser operating parameters.

MAL 532 Practical Laser Applications in Oral and Dental Medicine (3 Cr. Hrs.)

This is an introduction for the basics of using different lasers in Oral and Dental Medicine, including types, names, mode of action of all possible laser devices used in Oral and Dental Medicine and the indications, contraindications and the side effects (if any). There are demo application for minor training and some application on soft and hard tissues.



MAL 533 Applied Project in Laser Applications in Oral and Dental Medicine (4 Cr. Hrs.)

This is a special project related to oral and dental medicine based on the candidate's choice. At first all candidates make search for the up-to-date research topics in oral and dental medicine. According to topics candidates will be divided into small groups which are related to the same topics. During the course the students will be guided and advised in the method of research and how to write the project. They will be evaluated in two levels, in the group level and individual level with presentation for each student

MAL 534 Laser Applications in Pharmaceutical Sciences I (4 Cr. Hrs.)

The goal of this course is to enhance student understanding and knowledge of the application of laser technology in pharmaceutical science. Drug delivery systems. Photodynamic therapy, photosensitization, Pharmacokinetics, Drug photostability, photosensitive drugs. Industrial packages for photosensitive drugs. Pharmaceutical Biotechnology. Instrumental in pharmaceutical biotechnology. Assay of pharmaceutical formulations, Laser induced draining for tablets. Particle size analysis for pharmaceutical preparations. Laser light scattering and size distribution. Pharmaceutical microbiology for industrial sterilization.

MAL 535 Practical Laser Applications in Pharmaceutical Sciences (3 Cr. Hrs.)

This Course provides an introductory basic level of laboratory education to be satisfactorily on the use of laser in different medical fields, photodynamic therapy studies on cellular and animal models, use of laser in microbiological sterilization.

MAL 536 Applied Project in Laser Applications in Pharmaceutical Sciences (4 Cr. Hrs.)

It is a capstone project. Seminar and review of literature in a topic related to Laser Applications in Pharmaceutical Sciences. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 537 Laser Applications in Physiotherapy I (4 Cr. Hrs.)

The goal of this course is to enhance student understanding and knowledge of the application of laser technology in Physiotherapy This course provides an advanced level of didactic, laboratory, and clinical exercises to be satisfactorily on the use of laser in the Physiotherapy with knowledge of diagnosis and possible treatment alternatives, indication, contraindications and informed consent. Sound knowledge of treatment objective, laser operating parameters, management of complications, prognosis and follow-up care.

MAL 538 Practical Laser Applications in Physiotherapy (3 Cr. Hrs.)

This Course provides an introductory basic level of laboratory education to be satisfactorily on the use of medical laser equipment, and hands on laser with different fiber optics and free beam lasers, used in Physiotherapy. Use of laser through different delivery systems, Practical Knowledge of setting and adjusting the parameters of laser in Physiotherapy.

MAL 539 Applied Project in Laser Applications in Physiotherapy (4 Cr. Hrs.)

It is a capstone project. Seminar and review of literature in a topic related to Laser Applications in Physiotherapy. Evaluation and grades are based on seminar presentation, report and the final product.

**II. M.Sc. Degree:-****A) General Main Courses (6 Cr. Hrs.) for all specialties**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
MAL 601	Photomedicine II	2	2		
MAL 602	Molecular Biology	2	2		
MAL 603	Research Methodology and Biostatistics	2	1	2	

B) Special Main Courses (6 Cr. Hrs.) for each specialty

Specialty	Course		Credit Hours (Cr. Hrs.)	Contact Hours		
	Code	Course Name		Lecture	Exercise	Practical
Laser Applications in Surgery	MAL 604	Laser Applications in Surgery II	4	2	4	
	MAL 605	Scientific Project in Laser Applications in Surgery	2	1		2
Laser Applications in Dermatology	MAL 606	Laser Applications in Dermatology II	4	2	4	
	MAL 607	Scientific Project in Laser Applications in Dermatology	2	1		2
Laser Applications in Ophthalmology	MAL 608	Laser Applications in Ophthalmology II	4	2	4	
	MAL 609	Scientific Project in Laser Applications in Ophthalmology	2	1		2
Laser Applications in ENT	MAL 610	Laser Applications in ENT II	4	2	4	
	MAL 611	Scientific Project in Laser Applications in ENT	2	1		2



Laser Applications in Gynecology	MAL 612	Laser Applications in Gynecology II	4	2	4	
	MAL 613	Scientific Project in Laser Applications in Gynecology	2	1		2
Laser Applications in Pediatrics	MAL 614	Laser Applications in Pediatrics II	4	2	4	
	MAL 615	Scientific Project in Laser Applications in Pediatrics	2	1		2
Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	MAL 616	Laser Applications in Physical Medicine, Rheumatology and Rehabilitation II	4	2	4	
	MAL 617	Scientific Project in Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	2	1		2
Laser Applications in Oral and Dental Medicine	MAL 618	Laser Applications in Oral and Dental Medicine II	4	2	4	
	MAL 619	Scientific Project in Laser Applications in Oral and Dental Medicine	2	1		2
Laser Applications in Pharmaceutical Sciences	MAL 620	Laser Applications in Pharmaceutical Sciences II	4	2	4	
	MAL 621	Scientific Project in Laser Applications in Pharmaceutical Sciences	2	1		2
Laser Applications in Physiotherapy	MAL 622	Laser Applications in Physiotherapy II	4	2	4	
	MAL 623	Scientific Project in Laser Applications in Physiotherapy	2	1		2



MAL 601 Photomedicine II (2 Cr. Hrs.)

This course will address in depth the principles governing the interactions between light and biological tissues, their optical properties, principles of cell communications and basic concepts in photomedicine. Some physiological aspects related to laser applications will be covered supported by special case studies for such applications. In addition, the most important diagnostic and therapeutic applications of laser/light in medicine, computer aid analysis and spectroscopic systems that play a role in photomedicine will be described.

MAL 602 Molecular Biology (2 Cr. Hrs.)

This course provides a basic level of education of molecular biology and photobiology, it contains: Introduction of molecular biology, DNA structure and functions, Replication of DNA, structure and function of RNA, transcription of RNA, Gene expression, different types of mutations, Genetic diseases, Apoptosis and necrosis, Cancer and molecular biology, Cloning, ELISA, PCR (Polymerase chain reaction), Flowcytometry, Applications in molecular biology.

MAL 603 Research Methodology and Biostatistics (2 Cr. Hrs.)

Principles of research methodology, where students are introduced to research methodology, Code of Ethics in practice and research. Introduction to statistics, sampling a population, data types, describing data, estimation and confidence intervals, statistical inference, contingency tables, non-parametric tests, multiple comparisons, correlation and regression, diagnostic consistency, sample size calculations, bias and confounding, repeated measures, causation, critical appraisal.

MAL 604 Laser Applications in Surgery II (4 Cr. Hrs.)

This course is designed to enhance student understanding and knowledge of the application of laser technology in Surgery. This course provides in depth study of didactic and exercises to be satisfactorily on the use of laser in Surgery with knowledge of diagnosis and possible treatment alternatives, indication, contraindications, sound knowledge of treatment objective, laser operating parameters, management of complications, prognosis, and follow-up care.

MAL 605 Scientific Project in Laser Applications in Surgery (2 Cr. Hrs.)

A pilot research study on a topic related to laser applications in Surgery is nominated. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 606 Laser Applications in Dermatology II (4 Cr. Hrs.)

The goal of this course is to enhance student understanding and knowledge of the application of laser technology in Dermatology. This course provides in depth the study and the use of laser of different wavelengths for different skin diseases with knowledge of diagnosis and alternative options for management. Also expected complications, post-operative and follow up care will be discussed.

MAL 607 Scientific Project in Laser Applications in Dermatology (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Dermatology. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 608 Laser Applications in Ophthalmology II (4 Cr. Hrs.)

This course aims to supply the candidate with the necessary knowledge and practical skills he needs to practice laser in various ophthalmic procedure according to the preferred practice patterns of each procedure detailing indications, contraindication different laser parameters and complication management according to each technique based on ophthalmic benchmarks and professional standards. The candidate would be evaluated for his competence before allowing him to practice this specialty.



MAL 609 Scientific Project in Laser Applications in Ophthalmology (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Ophthalmology. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 610 Laser Applications in ENT II (4 Cr. Hrs.)

By the end of this course the student must have good knowledge and understanding of the all lasers used in ENT. He will be also able to adjust the dosimetry for each specific lesion treated by any type of laser. The student must be able to perform the maneuvers and operations and avoid the intraoperative complications. The student must understand and implement the photochemical effect of laser in ENT and its applications. He must be able to compare between the cold instrument surgical procedure and the laser procedures and choose the best for each pathology and predict the potentiality of laser in new surgical situations

MAL 611 Scientific Project in Laser Applications in ENT (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in ENT. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 612 Laser Applications in Gynecology II (4 Cr. Hrs.)

This course aims to increase the students understanding and knowledge of the applications of laser technology in Gynecology. It provides an in-depth study of the use of laser in Gynecology with the knowledge of various methods of diagnosis and treatment alternatives, and Indications and reasons for non-use. It increases and provides modern knowledge of the ways and methods of operation and the parameters necessary for applications, dealing with the impact of surgical complications, and follow-up care after laser sessions.

MAL 613 Scientific Project in Laser Applications in Gynecology (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Gynecology. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 614 Laser Applications in Pediatrics II (4 Cr. Hrs.)

In this course study of the applications of laser in the field of Pediatrics will be in more advanced level including the knowledge of the medical laser physics and safety. This course aims to provide the main aspects of genetics and pediatric diseases through lectures and exercises on demo, together with advanced knowledge of laser operating parameters and the use of light emitting diode phototherapy and laser acupuncture in different pediatric and genetic diseases, considering the latest knowledge and techniques in laser applications.

MAL 615 Scientific Project in Laser Applications in Pediatrics (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Pediatrics. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 616 Laser Applications in Physical Medicine, Rheumatology and Rehabilitation II (4 Cr. Hrs.)

This course is planned to provide a deep understanding of the application of different types of laser in the Physical medicine, Rheumatology and Rehabilitation. The main target of this course is to provide the candidate with knowledge as regards the physical characteristics, physiological effects and physical effects of LLLT. The course will provide a full understanding of pathogenesis, pathophysiology and the differential diagnosis of diseases meant to be treated with LLLT therapy. It also includes contraindications for the use of this modality, management of complications and the possible treatment alternatives for those patients, focusing on treatment objective and laser operating parameters.



MAL 617 Scientific Project in Laser Applications in Physical Medicine, Rheumatology and Rehabilitation (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Physical medicine, Rheumatology and Rehabilitation. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 618 Laser Applications in Oral and Dental Medicine II (4 Cr. Hrs.)

In this course study of the applications of laser in the field of Oral and Dental Medicine will be in more advanced level including the knowledge of the medical laser physics and safety. Fundamental concepts describing the different laser applications in different specialties such as oral surgery, periodontology, restorative dentistry and dental materials. This course aims to provide the main aspects of through lectures and exercises on demo, together with advanced knowledge of laser operating parameters.

MAL 619 Scientific Project in Laser Applications in Oral and Dental Medicine (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Oral and Dental Medicine. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 620 Laser Applications in Pharmaceutical Sciences II (4 Cr. Hrs.)

The goal of this course is to enhance student understanding and knowledge of the application of laser technology in Pharmaceutical Sciences and technology. In depth study of photodynamic processes. Drug delivery systems for photodynamic therapy, photosensitizers, Pharmacokinetics, Drug photostability, photosensitive drugs. Industrial packages for photosensitive drugs. Pharmaceutical Biotechnology. Instrumentation in pharmaceutical technology. Assay of pharmaceutical formulations, Laser induced draining for tablets. Particle size analysis for pharmaceutical preparations. Laser light scattering and size distribution. Pharmaceutical microbiology for industrial sterilization.

MAL 621 Scientific Project in Laser Applications in Pharmaceutical Sciences (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Pharmaceutical Sciences. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 622 Laser Applications in Physiotherapy II (4 Cr. Hrs.)

The goal of this course is to enhance knowledge of various kinds of laser devices used in Physiotherapy and the differences between them. To enhance knowledge and understanding of different techniques of LLLT, its biological effects as well as mechanisms of LLLT. It will enhance the understanding of the guidelines of LLLT in medical conditions that could be treated with laser, choose the suitable device; calculate the dose and other different parameters. Sound knowledge of the side effects, contraindications, and precautions of LLLT. They would be able to choose the suitable modality used for wound healing according to the clinical condition.

MAL 623 Scientific Project in Laser Applications in Physiotherapy (2 Cr. Hrs.)

A pilot research study in a topic related to laser applications in Physiotherapy. Evaluation and grades are based on seminar presentation, report and the final product.

**III. Ph.D. Degree:-****A) General Elective Courses (4 Cr. Hrs.) for all specialties**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
MAL 701	Nanotechnology in Medicine	2	1	2	
MAL 702	Bioengineering	2	2		
MAL 703	Clinical Optics	2	2		
MAL 704	Critical Appraisal	2	2		

B) Special Main Courses (8 Cr. Hrs.) for each specialty

Specialty	Course		Credit Hours (Cr. Hrs.)	Contact Hours		
	Code	Course Name		Lecture	Exercise	Practical
Laser Applications in Surgery	MAL 705	Laser Applications in Surgery III	6	4		4
	MAL 706	Advanced Scientific Project in Laser Applications in Surgery	2	1		2
Laser Applications in Dermatology	MAL 707	Laser Applications in Dermatology III	6	4		4
	MAL 708	Advanced Scientific Project in Laser Applications in Dermatology	2	1		2
Laser Applications in Ophthalmology	MAL 709	Laser Applications in Ophthalmology III	6	4		4
	MAL 710	Advanced Scientific Project in Laser Applications in Ophthalmology	2	1		2
Laser Applications in ENT	MAL 711	Laser Applications in ENT III	6	4		4
	MAL 712	Advanced Scientific Project in Laser Applications in ENT	2	1		2



Laser Applications in Gynecology	MAL 713	Laser Applications in Gynecology III	6	4		4
	MAL 714	Advanced Scientific Project in Laser Applications in Gynecology	2	1		2
Laser Applications in Pediatrics	MAL 715	Laser Applications in Pediatrics III	6	4		4
	MAL 716	Advanced Scientific Project in Laser Applications in Pediatrics	2	1		2
Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	MAL 717	Laser Applications in Physical Medicine, Rheumatology and Rehabilitation III	6	4		4
	MAL 718	Advanced Scientific Project in Laser Applications in Physical Medicine, Rheumatology and Rehabilitation	2	1		2
Laser Applications in Oral and Dental Medicine	MAL 719	Laser Applications in Oral and Dental Medicine III	6	4		4
	MAL 720	Advanced Scientific Project in Laser Applications in Oral and Dental Medicine	2	1		2
Laser Applications in Pharmaceutical Sciences	MAL 721	Laser Applications in Pharmaceutical Sciences III	6	4		4
	MAL 722	Advanced Scientific Project in Laser Applications in Pharmaceutical Sciences	2	1		2
Laser Applications in Physiotherapy	MAL 723	Laser Applications in Physiotherapy III	6	4		4
	MAL 724	Advanced Scientific Project in Laser Applications in Physiotherapy	2	1		2



MAL 701 Nanotechnology in Medicine (2 Cr. Hrs.)

This course provides an insight on the basic concepts of nanomedicine, a description of the very latest advances in knowledge, skills and techniques in nanotechnology and nanomedicine and a future look to their potential applications in diagnosis and therapy. Innovative study methods will be employed, including access to state of the art equipments for nanomaterials preparation and characterization.

MAL 702 Bioengineering (2 Cr. Hrs.)

It provides an overview of methods/instruments for noninvasive investigation of tissue function. This subject offers a technical analysis of each instrument, allowing candidates to understand its biophysical principles. Topics include tissue water loss, hydration, the measurement of tissue blood flow in Laser-Doppler flowmetry, pH and ions, and pO_2 and pO_2 measurements. Tissue color, roughness, and elasticity are examined in detail. Tissue imaging techniques, capillaroscopy, and fluorescence video microscopy are described. Instruments for surface microscopy are also discussed.

MAL 703 Clinical Optics (2 Cr. Hrs.)

The student should be able to provide the basic knowledge in optics to understand the matter of optics in the form of physics, geometrical, physiological optics and to discuss the different aberrations and optical principles.

MAL 704 Critical Appraisal (2 Cr. Hrs.)

In this course students will gain knowledge and understanding about the journal, organization of the article, the clinical question, methodology, observational descriptive and analytical studies, experimental studies, and research pathway.

MAL 705 Laser Applications in Surgery III (6 Cr. Hrs.)

This Course provides in depth study and an advanced level of didactic and clinical exercises to be satisfactorily on the use of laser in Surgery with knowledge of diagnosis and possible treatment alternatives, indication, contraindications, treatment objective, laser operating parameters, management of complications, surgical prognosis, and post lasing follow-up care.

MAL 706 Advanced Scientific Project in Laser Applications in Surgery (2 Cr. Hrs.)

It is an advanced retrospective or prospective analytic study that focuses on a selected topic related to laser applications in field of Surgery. Candidate will define a research hypothesis, develop a research plan, collect and analyze data, interpret findings, and conduct a review of literature. Evaluation and grades are based on seminar presentation, report and final product.

MAL 707 Laser Applications in Dermatology III (6 Cr. Hrs.)

This course presents the most up-to-date description of the latest in laser and light-source technology after describing latest understanding of laser physics and safety aspects. It will describe a wide variety of cutaneous problems and the latest understanding of their laser treatment. Updates in Photodynamic therapy and their new indications. Nanotechnology field in Dermatology.

MAL 708 Advanced Scientific Project in Laser Applications in Dermatology (2 Cr. Hrs.)

It is an advanced project. A pilot research study in a topic related to laser applications in Dermatology. Evaluation and grades are based on seminar presentation, report and the final product.



MAL 709 Laser Applications in Ophthalmology III (6 Cr. Hrs.)

This course provides in depth study and an advanced level of didactic and clinical exercises to be satisfactorily on the use of laser in Ophthalmology with knowledge of diagnosis and possible treatment alternatives, indication, contraindications, treatment objective, laser operating parameters, management of complications, prognosis and follow-up care.

MAL 710 Advanced Scientific Project in Laser Applications in Ophthalmology (2 Cr. Hrs.)

It is an advanced project. A review of literature in topic related to laser application in ophthalmology. Evaluation and grades are based on seminar presentation report and final product.

MAL 711 Laser Applications in ENT III (6 Cr. Hrs.)

By the end of this course the candidate must have full knowledge and understanding of the use of laser in ENT. Execute different surgical operations the use laser as an absolute or relative indication. Analyze and differentiate between different pathological statuses that can benefit from laser treatment. He can generate and/or plan optimum surgical mechanisms or operations or deliver the state of the art of laser science and its applications in ENT.

MAL 712 Advanced Scientific Project in Laser Applications in ENT (2 Cr. Hrs.)

By the end of this course, the candidate should: Perform all operations done by laser in ENT. Should calculate the dosimetry needed for each treatment. Should evaluate and solve any new situations that may need laser in ENT and deal with it, can conduct the state of the art information to the younger generation regarding teaching them practical, clinical and theoretical information.

MAL 713 Laser Applications in Gynecology III (6 Cr. Hrs.)

This course is designed to introduce the student to laser fundamentals and frontline applications in the field of Gynecology. This includes lasers used in Gynecology, surgical laser delivery in Gynecology, comparison between different energy sources and laser in surgery, role of laser in laparoscopy. Management of endometriosis and laser applications in lower genital tract, laparoscopic laser surgery, uterine disorders and laser applications, laser applications in assisted reproductive technology, uterine fibroids and laser treatment, laser application during pregnancy and in some obstetric disorders. It also introduces the student to future use of laser in Gynecology and new technologies and laser applications.

MAL 714 Advanced Scientific Project in Laser Applications in Gynecology (2 Cr. Hrs.)

A research project related to obstetrics and Gynecology or laser application in the field. This project can be either a retrospective or a prospective analysis in which the resident will define a research hypothesis, develop and implement a research plan, collect and analyze data, interpret findings, conduct a literature review related to a topic of study and prepare a manuscript suitable for publication and presentation. The projects may be done individually or in a group of students

MAL 715 Laser Applications in Pediatrics III (6 Cr. Hrs.)

The goal of this course is to enhance student understanding and knowledge of the medical laser application in Pediatrics. This course provides in depth study and an advanced level of educational and clinical exercises to be satisfactorily on the use of laser in the Pediatrics and genetics with knowledge of diagnosis, indications, contraindications and possible treatment alternatives using laser, Light emitting diode and laser acupuncture. This course provides the correct knowledge of treatment objectives, and methods, laser operating parameters, management of complications, post session instructions and follow-up care.



MAL 716 Advanced Scientific Project in Laser Applications in Pediatrics (2 Cr. Hrs.)

Each candidate chooses a topic in Pediatrics (diagnostic or therapeutic laser in one of the Pediatrics diseases), it will be a training for doing research and how to do an international publication.

MAL 717 Laser Applications in Physical Medicine, Rheumatology and Rehabilitation III (6 Cr. Hrs.)

This course is planned to provide a deep understanding of the application of laser in Physical Medicine, Rheumatology and Rehabilitation. The main target of this advanced course is to provide the candidate with an in depth knowledge as regards the physical characteristics, physiological effects and physical effects of LLLT. The course will provide a full understanding of pathogenesis, pathophysiology and the differential diagnosis of diseases meant to be treated with LLLT therapy. It also includes contraindications for the use of this modality, management of complications, the possible treatment alternatives, treatment objective and laser parameters.

MAL 718 Advanced Scientific Project in Laser Applications in Physical Medicine, Rheumatology and Rehabilitation (2 Cr. Hrs.)

This project provides the students with the opportunity to apply and implement the skills they have gained during their studying courses in one of the topics of laser applications in Physical Medicine, Rheumatology and Rehabilitation. All the student education including lectures, tutorials and labs should be reflected on the project. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 719 Laser Applications in Oral and Dental Medicine III (6 Cr. Hrs.)

This course offers an advanced education in the recent topics of different dental laser applications. It provides a comprehensive training on the recent dental laser applications in oral surgery, periodontology, different restorative dental practice, as well as the clinical applications of the recent research outcome in the field of dental laser applications. It provides a chance to develop both research and clinical skills of post graduate student.

MAL 720 Advanced Scientific Project in Laser Applications in Oral and Dental Medicine (2 Cr. Hrs.)

This project provides the students with the opportunity to apply and implement the skills they have gained during their studying courses in one of the topics of laser applications in Oral and Dental Medicine. Evaluation and grades are based on seminar presentation, report and the final product.

MAL 721 Laser Applications in Pharmaceutical Sciences III (6 Cr. Hrs.)

The goal of this course is to enhance the students to acquire, compare, operate, calculate, combine and evaluate updates in laser applications in Pharmaceutical Sciences and technology and use of drug delivery systems and nanotechnology in photodynamic therapy and be able to participate and cooperate in research work in the field.

MAL 722 Advanced Scientific Project in Laser Applications in Pharmaceutical Sciences (2 Cr. Hrs.)

It is an advanced project. A review of literature and pilot research study in a topic related to Laser Applications in Pharmaceutical Sciences. Evaluation and grades are based on seminar presentation, report and the final product.

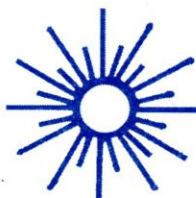


MAL 723 Laser Applications in Physiotherapy III (6 Cr. Hrs.)

The goal of this course is to enhance knowledge and understanding of various kinds of laser devices used in Physiotherapy and the differences between them. To enhance knowledge and understanding of different techniques of LLLT, its biological effects as well as mechanisms of LLLT. In depth study of the guidelines of LLLT in medical conditions that could be treated with laser, choose the suitable device; calculate the dose and other different parameters. In depth study and enhance understanding of the side effects, contraindications, and precautions of LLLT. Enhance the knowledge of different physical modalities used for wound healing and choose the suitable modality. They will recognize different physical modalities for pain management and the underlying mechanism of its action

MAL 724 Advanced Scientific Project in Laser Applications in Physiotherapy (2 Cr. Hrs.)

This project provides the students with the opportunity to apply and implement the skills they have gained during their studying courses in one of the topics of laser applications in Physiotherapy. Evaluation and grades are based on seminar presentation, report and the final product.



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S
Cairo University



جامعة القاهرة

اللائحة الداخلية للدراسات العليا (٢٠١٦م)

المعهد القومى لعلوم الليزر

Department of Laser Applications in Metrology, Photochemistry and Agriculture (LAMPA)



Department of Laser Applications in Metrology, Photochemistry and Agriculture (LAMP)

Department of Laser Applications in Metrology, Photochemistry and Agriculture (LAMP) offers the candidates the opportunity to study for the Diploma, M.Sc. Degree and Ph.D. Degree in one of the following specialties:-

1. Laser Applications in Metrology (LAM)
2. Photochemistry and Photobiology (PP)
3. Laser Applications in Biotechnology and Agriculture (LABA)

I. Diploma:-

A) General Main Courses (5 Cr. Hrs.) for all specialties

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LAMP 501	Fundamentals of Laser	2	2		
LAMP 502	Fundamentals of Optics	2	2		
LAMP 503	Laser Safety	1	1		

B) Special Main Courses (13 Cr. Hrs.) for the specialty of Laser Applications in Metrology (LAM)

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
LAM 501	Laser Measuring Instruments	3	2		2	
LAM 502	Laser Metrology	2	2			LAMP 501 LAMP 502
LAM 503	Nonlinear Optics	2	2			LAMP 501 LAMP 502
LAM 504	Applied Project	4			8	LAMP 501 LAMP 502
LAM 505	Atomic and Molecular Physics	2	2			

**C) Special Elective Courses (6 Cr. Hrs.) for the specialty of Laser Applications in Metrology (LAM)**

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
LAM 506	Environmental Laser Studies	2	2			
LAM 507	Fiber Optics	2	2			LAMPA 501 LAMPA 502
LAM 508	Laser in Nanotechnology	2	2			
LAM 509	Laser Media	2	2			LAMPA 501 LAMPA 502

D) Special Main Courses (17 Cr. Hrs.) for the specialty of Photochemistry and Photobiology (PP)

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
PP 501	Photochemistry 1	2	2			
PP 502	Photobiology 1	2	2			
PP 503	Photochemistry 2	3	2		2	PP 501
PP 504	Photobiology 2	3	2		2	PP 502
PP 505	Ultracellular Structure & Molecular Biology	2	2			
PP 506	Nano-Chemistry	3	2		2	
PP 507	Environmental Photochemistry & Photobiology	2	2			PP 501 PP 502

E) Special Elective Course (2 Cr. Hrs.) for the specialty of Photochemistry and Photobiology (PP)

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
PP 508	Photobiological Techniques	2	1		2	PP 502
PP 509	Bio-Nanotechnology	2	1		2	

F) Special Main Courses (15 Cr. Hrs.) for the specialty of Laser Applications in Biotechnology and Agriculture (LABA)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LABA 501	Laser Applications in Agricultural Biotechnology	3	2		2
LABA 502	Laser Applications in Agricultural Mechanization	3	2		2
LABA 503	Color Analysis of Agricultural Products	2	1		2
LABA 504	Research Project	2	1		2
LABA 505	Measurement and Analysis Instruments	3	2		2
LABA 506	Pollutants and Genotoxicity in Agriculture	2	2		

**G) Special Elective Courses (4 Cr. Hrs.) for the specialty of Laser Applications in Biotechnology and Agriculture (LABA)**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LABA 507	Genes – Genomes in Agricultural Biotechnology	2	2		
LABA 508	Laser in Animal Production	2	2		
LABA 509	Laser in Soil and Water Engineering	2	2		
LABA 510	Renewable Energy	2	2		

LAMPA 501 Fundamentals of Laser (2 Cr. Hrs.)

Introduction and historical synopsis, absorption and emission of electromagnetic waves, major properties of laser light, physical mechanisms of laser emission, light amplification, population inversion, laser oscillators and stability conditions, 3 level and 4 level lasers, laser efficiency, laser modes, different types of lasers with some real examples.

LAMPA 502 Fundamentals of Optics (2 Cr. Hrs.)

Introduction to optics: 1) Geometrical optics: Reflection, refraction of light, Image formation with lenses, Image formation with mirrors, the optical microscope. 2) Physical optics: Superposition of Waves, Interference of light, Diffraction of light, Polarization of light, some laser related applications on geometrical and physical optics.

LAMPA 503 Laser Safety (1 Cr. Hr.)

Introduction to laser (characteristics, laser parameters including power, wavelength, pulse duration and laser types). Concepts of laser safety. Interaction of laser with biological tissues. Evaluation of Laser hazards and non-beam hazards. Standard Operating procedures and control measures. Laser safety rules and recommendations.

LAM 501 Laser Measuring Instruments (3 Cr. Hrs.)

Analog and Digital Systems (DAC and ADC), data acquisition systems, pulse width meters techniques, simple methods autocorrelations, Streak camera, operational amplifiers, wave meters, Michelson wave meter, Fabry-Perot wave meter, laser Detectors.

LAM 502 Laser Metrology (2 Cr. Hrs.)

Prerequisites: Fundamentals of Laser (LAMPA 501), Fundamentals of Optics (LAMPA 502)

Light sources and detectors. Types of interferometers. Using different interferometric techniques in measuring distances, velocities, temperature and surface morphology. Using laser interference in measuring gravitational waves. Speckle method and fringe analysis. The polarization of light. Applications of light polarization in measurements.

LAM 503 Nonlinear Optics (2 Cr. Hrs.)

Prerequisites: Fundamentals of Laser (LAMPA 501), Fundamentals of Optics (LAMPA 502)

The semi-classical model of the nonlinear laser-matter interaction. Harmonics generation, Pockels' effect, nonlinear wave-mixing, crystal optics, phase matching, parametric generation. Ultrafast phenomena in molecules and solids, optical Stark effect. Kerr effect, self-focusing.



LAM 504 Applied Project (4 Cr. Hrs.)

Prerequisites: Fundamentals of Laser (LAMPA 501), Fundamentals of Optics (LAMPA 502)

Open topics. The students meet their project supervisor for discussion about selected topics according to their field of interest and background.

LAM 505 Atomic and Molecular Physics (2 Cr. Hrs.)

Atomic Spectra and the Bohr model of hydrogen atom. The Stern-Gerlach experiment, angular momentum and spin. De Broglie's hypothesis and the genesis of wave mechanics. The Schrödinger equation of the one-electron atom. Energy levels. Interaction of one electron atom with electromagnetic radiation, selection rules and the spectrum of one electron atoms, line intensities, line shapes and widths. The Fine structure of hydrogen atoms, Zeeman and Stark effects. Molecular structure (general nature). Rotation and vibration of diatomic molecules, electronic structure. Molecular spectra.

LAM 506 Environmental Laser Studies (2 Cr. Hrs.)

Laser RADAR (LIDAR) and applications. Using laser techniques to measure pollutants in different media. Spectroscopic techniques. Biochemical applications of laser techniques.

LAM 507 Fiber Optics (2 Cr. Hrs.)

Prerequisites: Fundamentals of Laser (LAMPA 501), Fundamentals of Optics (LAMPA 502)

Introduction to fiber optics. Physics of fiber optics. Optical-Cable Construction. Propagation Modes. Characteristics of Fiber Optic. Components of Fiber Optics, fabrication and types. Fiber-Optic applications.

LAM 508 Laser in Nanotechnology (2 Cr. Hrs.)

Introduction to lasers and laser systems nanotechnology. Laser ablation for the preparation of nanomaterials and advantages. Surface modification of nanomaterials under laser effect. Laser for identification of the particle size. The contribution of nanomaterials in enhancing LIBS spectra in term of surface enhancing LIBS spectroscopy. Nanomaterials as lasing media in laser systems. Nanotech-laser kills cancer as a medical application. 3D laser microscopy for nanotechnology and metrology.

LAM 509 Laser Media (2 Cr. Hrs.)

Prerequisites: Fundamentals of Laser (LAMPA 501), Fundamentals of Optics (LAMPA 502)

Study of different active media (Solids, Gasses, Liquids). Relevant optical components (lenses, optical wave plates, windows, Polarizer's, etc.). Non-linear crystals used in laser systems and applications (e.g. Harmonic Generation crystals, etc.).

PP 501 Photochemistry 1 (2 Cr. Hrs.)

Photochemical principles, Jablonski diagram and transitions between electronic excited states, photophysical and photochemical processes. Kinetics of photophysical and photochemical processes. Applied Photochemistry.

PP 502 Photobiology 1 (2 Cr. Hrs.)

Introduction to photobiology. Photosensitization process. Action spectroscopy. Photosynthesis. Photobioregulatory mechanisms. Bioluminescence.

PP 503 Photochemistry 2 (3 Cr. Hrs.)

Prerequisite: Photochemistry 1 (PP 501)

Energy transfer processes. Proton transfer and its applications. Amplified spontaneous emission and its applications. Fluorescence techniques. Lifetimes of electronically excited states and flash photolysis. Thermal lensing and polarized fluorescence, laser dyes, photorganic reactions.



PP 504 Photobiology 2 (3 Cr. Hrs.)

Prerequisite: Photobiology 1 (PP 502)

Applications of photosensitization, Marine photobiology, Plant Photobiology, The role of natural pigments in our life, Recent applications in photobiology.

PP 505 Ultracellular Structure & Molecular Biology (2 Cr. Hrs.)

Biomembrane Models, Cellular processes, Cell death mechanisms, Basic methods in cellular and molecular biology, Open topic in cell biology.

PP 506 Nano-Chemistry (3 Cr. Hrs.)

Introduction to nano-science, Physico-chemical considerations, Method of preparation, Analysis and characterization of nanoscale materials, Surface modification and functionalization, Plasmonic, Carbon nanomaterials, Semiconductor Quantum dots.

PP 507 Environmental Photochemistry & Photobiology (2 Cr. Hrs.)

Prerequisite: Photochemistry 1 (PP 501) & Photobiology 1 (PP 502)

Solar radiation, Photo-protection mechanisms, Biological consequences of ozone depletion, Biological action spectra, Environmental photo-remediation, UVB radiation and its effect on human health and environment, Light and waste management.

PP 508 Photobiological Techniques (2 Cr. Hrs.)

Prerequisite: Photobiology 1 (PP 502)

A non-Invasive therapeutic and diagnostic techniques for *in vivo* studies, Photochemistry and Photobiology of Tetrapyrrole Pigments, Membrane Photomodification, Chlorophyll fluorescence transients in Chloroplasts and leaves, Effects of Light on Circadian Rhythms in plants and animals, photosensitization setup experiments.

PP 509 Bio-Nanotechnology (2 Cr. Hrs.)

Organic and inorganic nanomaterials, Biomedical applications research of nanomaterials like drug delivery, therapeutic and cancer diagnostic research, gene delivery, antimicrobial agents..., etc. Applications of nanotechnology in dental and cosmetic materials, Bionanosensor, Nanotoxicology, Nanopesticides.

LABA 501 Laser Applications in Agricultural Biotechnology (3 Cr. Hrs.)

The plant cell, Mechanisms of plant cell signaling and gene regulation, Function of plant hormones, Plant metabolic pathways. Different methods for transformation and applications, transcriptomics, proteomics, metabolomics and biological systems. Environmental biotechnology: Bioremediation and Phytoremediation, Biofeasibility, applications of bioremediation, Bioreduction. Animal production technology: Covers all aspects of animal reproduction, genetics, breeding, nutrition, physiology. Dairy science and technology.

LABA 502 Laser Applications in Agricultural Mechanization (3 Cr. Hrs.)

Introduction. The principle of machine controls system. Effect of laser land leveling on physical properties of soil. Mechanization of the farm operation. Farm machinery performance. Equipment of leveling. Leveling types. Contouring. Laser land leveling equipment. Laser application in sub-surface drainage. Laser control in sorting and grading machines. *Lab*: Simulator of laser machine control system. Types of Agricultural Machines. Equipment of leveling. Components of the transmitter and telescopic rod. The operation of the transmitter and telescopic rod. Maintenance and calibration procedures of the transmitter. Precise alignment of axes. Axes alignment for steep slopes. Leveling types. Laser leveling and equipment. Component and operation of sub-surface drainage machine. Laser in processing of sorting and grading.



LABA 503 Color Analysis of Agricultural Products (2 Cr. Hrs.)

Preface. Food color and appearance in perspective. The philosophy of total appearance laser light and interaction with materials. Vision sensory evaluation of appearance: methodology, appearance profile analysis, and sensory scales. Instrumental specification: Color specification of food, specification of appearance properties other than color. The chemistry of food color the environment and food display. *Lab:* set up a vision for grains, vegetable, fruits and biological material. The color analysis program for agricultural products.

LABA 504 Research Project (2 Cr. Hrs.)

The students meet their advisor for discussion and project management. It is a capstone project. Seminar and review of literatures in agricultural topic related to the elective courses and specialty. The students form groups and select the topics according to their field of interest and background.

LABA 505 Measurement and Analysis Instruments (3 Cr. Hrs.)

Analog and Digital Systems (DAC and ADC), operational amplifiers, Wave meters, Laser Detectors, Instruments of electric and electronics, optical meters, Instruments of agricultural engineering, color analysis meter, Instruments of agricultural biotechnology.

LABA 506 Pollutants and Genotoxicity in Agriculture (2 Cr. Hrs.)

Plant environmental stress, plant response, and adaptation to abiotic stress. Plant response and adaptation to biotic stress (bacterial, fungal, parasite, insects) and plant pathogen interaction. Plant environmental stress. Monitoring through Laser-based techniques, functional genomics, metabolite profiling. Pesticide genotoxicity and monitoring methods.

LABA 507 Genes – Genomes in Agricultural Biotechnology (2 Cr. Hrs.)

Introduction. Genes: organization in prokaryotes and eukaryotes. Gene expression and regulation. Gene tree. Gene pole. Gene family. Gene silencing. Gene frequency in a population. Gene detection methods. Genome: structure in prokaryotes (bacteria), eukaryotes (cattle, sheep, goat, yeast, rice, fish, mouse and poultry) and gametes (sperm, egg and pollen grains). Genome mutation. Genome analysis. Genome sequencing. Genome and genomics. Laser applications in each field.

LABA 508 Laser in Animal Production (2 Cr. Hrs.)

Introduction, animal production systems (milk system etc.). High quality and quantity of farm animal productivity (beef and dairy cattle production, poultry and fish production.... etc.). Animal nutrition and physiology. Genetics and breeding. Animal productivity (semen analysis, artificial insemination, embryo transfer,...etc.). Animal health and diseases. Fertility and sterility. Laser applications in each field.

LABA 509 Laser in Soil and Water Engineering (2 Cr. Hrs.)

Preface. Soil physical and chemical properties. Laser detection of soil taxonomy. Drainage pollution of soil. Detection heavy metal in soil and water.

LABA 510 Renewable Energy (2 Cr. Hrs.)

Introduction (Energy and Environmental Issues), Renewable Energy recourses, Bio energy tools, Biomass Resources, Principles of Biomass Utilization, Solar Energy tools, Solar Energy in agricultural application (water, pumps, drying, electric and heating), Wind Energy tools; Wind Energy utilization (water, pumps, milling, electric and heating), Earth energy in agricultural application.

**II. M.Sc. Degree:-****A) General Main Courses (5 Cr. Hrs.) for all specialties**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LAMPA 601	Fundamentals of Spectroscopy	2	2		
LAMPA 602	Biosafety	1	1		
LAMPA 603	Statistics and Computer Science	2	1	2	

B) Special Main Courses (5 Cr. Hrs.) for the specialty of Laser Applications in Metrology (LAM)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LAM 601	Laser Physics	2	2		
LAM 602	Optoelectronics	1	1		
LAM 603	Laser Remote Sensing	2	2		

C) Special Elective Course (2 Cr. Hrs.) for the specialty of Laser Applications in Metrology (LAM)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LAM 604	Experimental Studies	2			4
LAM 605	Plasma Physics	2	2		
LAM 606	Laser Operation Arrangements	2	1		2
LAM 607	Theoretical Atomic Physics	2	2		

D) Special Main Courses (5 Cr. Hrs.) for the specialty of Photochemistry and Photobiology (PP)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
PP 601	Applications in Nanotechnology	2	2		
PP 602	Advanced Photochemistry and Photobiology	3	2		2

E) Special Elective Course (2 Cr. Hrs.) for the specialty of Photochemistry and Photobiology (PP)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
PP 603	Advanced Optical Spectroscopy	2	1		2
PP 604	Laser Tissue Interaction	2	2		
PP 605	Laser Induced Chemistry	2	2		

**F) Special Elective Courses (7 Cr. Hrs.) for the specialty of Laser Applications in Biotechnology and Agriculture (LABA)**

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LABA 601	Nanotechnology in Agriculture	3	2		2
LABA 602	Physical and Optical Properties of Agricultural Products	2	1		2
LABA 603	Laser in Animal and Crops Improvement	2	2		
LABA 604	Laser in Gene Technology for Agricultural Improvement	2	2		
LABA 605	Agricultural Bioinformatics and Biosafety	2	2		
LABA 606	Techniques in Agricultural Biotechnology	2	1		2
LABA 607	Laser Control in Agricultural Machines	2	1		2
LABA 608	Machine Vision of Agricultural Products	2	2		

LAMPA 601 Fundamentals of Spectroscopy (2 Cr. Hrs.)

Introduction to spectroscopy, radiometric and photometric units, Laser irradiances (CW & Pulsed), measurement of optical power, photoemission devices, photovoltaic and photoconductive devices, thermal detectors, different types of spectroscopy [Atomic spectroscopy (ICP and LIBS), Molecular Spectroscopy (Raman and FTIR)].

LAMPA 602 Biosafety (1 Cr. Hr.)

Fundamentals of Biosafety, Waste Management, Laboratories & safety equipment, Risk assessment and management, Hygiene, Disinfection, Decontamination, Biosafety in animal facilities, Biosecurity.

LAMPA 603 Statistics and Computer Science (2 Cr. Hrs.)

Statistical methods, variables. distributions, data representation, presentation of quantitative data, measurement of central tendency, measurement of dispersion, Biostatistics, Survival Analysis, Design and evaluation of studies of populations, multivariate computer methods, Introduction to MATLAB.

LAM 601 Laser Physics (2 Cr. Hrs.)

Fundamentals of the interaction of light with matter. Fundamentals of lasers for ultrashort light pulses and relevant techniques. Methods of measurements. Q- Switching, Mode locking. Synchronously pumped lasers. Metal vapor lasers, Chemical Lasers, Fiber Lasers.

LAM 602 Optoelectronics (1 Cr. Hr.)

Electro-optics Devices. Magneto-optics Devices, Acousto-optics Devices, Display Devices, Optical feedback, Laser modes (single-mode, multi-mode), Q Switching control.



LAM 603 Laser Remote Sensing (2 Cr. Hrs.)

Electromagnetic theory. Wave propagation in isotropic media. Interaction of radiation and atomic systems. The classical theory of scattering. The different types of laser interaction process including scattering processes. Propagation through the atmosphere. Laser systems for remote-sensing. Atmospheric LIDAR. The general Laser remote sensing equation. LIDAR components and some of its applications (e.g. atmosphere pollution detection, Weather forecasts, etc.).

LAM 604 Experimental Studies (2 Cr. Hrs.)

Some selected experiments related to laser physics, laser spectroscopy, and metrology will be studied in details.

LAM 605 Plasma Physics (2 Cr. Hrs.)

Introduction to plasma physics. The motion of charged particles in the electromagnetic field. Magneto-ionic theory including electron conductivity and mobility. Wave propagation in plasma. Plasma kinetic theory with emphasis on Boltzmann, The Vlasov-Fokker-Planck equation. Plasma Sheath.

LAM 606 Laser Operation Arrangements (2 Cr. Hrs.)

Fundamentals of Laser Emission, Laser cavity in a different Lasers, Laser pumping techniques, Examples of lasers. Laser Control (Mechanical, Active Q-Switching, Passive Q-Switching, etc.), Frequency doubling techniques. Wavelength tuning. Energy attenuation. Laser pulse stretching and compression.

LAM 607 Theoretical Atomic Physics (2 Cr. Hrs.)

Wave functions and equation of motion. Angular momentum and spin. One-electron systems. Many-electron systems. The N-electron problem. Electromagnetic transitions.

PP 601 Applications in Nanotechnology (2 Cr. Hrs.)

Nanomaterials Fabrication and characterization, Optical and Electronic Properties of nanomaterials, Industrial applications of nanotechnology in constructions, textiles & petrochemicals. Nanomaterials for solar cells, electronic devices and sensors. Biomedical applications research of nanotechnology, Nanotechnology in agriculture.

PP 602 Advanced Photochemistry and Photobiology (3 Cr. Hr.)

This course deals with advanced topics in the field of photochemistry and photobiology in the following topics: Photochemistry of biomolecules, Applied Photochemistry, concepts of Molecular Biology and Immunology, DNA photodamage and repair, Photoimmunology, Photocarcinogenesis.

PP 603 Advanced Optical Spectroscopy (2 Cr. Hrs.)

Electronic structure, Selection rules, and optical transitions in molecules and condensed matters, Linear and non-linear optical properties, Steady state spectroscopy, Raman and Fourier transform infrared spectroscopy (FTIR) spectroscopy, Laser induced fluorescence, Time-resolved laser techniques, Flash photolysis, Pump-probe transient absorption techniques.

PP 604 Laser Tissue Interaction (2 Cr. Hrs.)

Introduction, optical properties of tissue, Types of Laser-tissue Interaction (Photochemical, Photothermal, Photoablation, Plasma-induced ablation, photomechanical/photodisruption), Applications and techniques.

PP 605 Laser Induced Chemistry (2 Cr. Hrs.)

Specialized laser absorption techniques (Excitation, Ionization, Thermal lensing, photoacoustic & optogalvanic spectroscopy). Laser-induced reactions (unimolecular & bimolecular reactions, laser-sensitized reactions, ...etc.). Chemical spectroscopy with lasers (laser induced atomic & molecular fluorescence, Raman spectroscopy, multi-photon spectroscopy, laser mass spectrometry).



LABA 601 Nanotechnology in Agriculture (3 Cr. Hrs.)

Nanotechnology: introduction, classification of nanoparticles, preparation and methodologies, examples etc. Nanotechnology in agriculture: introduction, applications in agriculture (crops quality and quantity, crops production, food processing gene delivery,....etc.). Trials in animal production....etc.

LABA 602 Physical and Optical Properties of Agricultural Products (2 Cr. Hrs.)

Introduction. Basic concepts of physical properties of plant and animal material Light: basic laws, interaction with matter, measurement and establishing quality indices. Light transmittance and reflectance properties of agricultural products. Interior characteristics of fruits and vegetables. Some applications on laser uses: maturity and surface color determination, detection of products defect, milling degree of grain, detection of surface defect biological material, insect infection in product and moisture content of grain. Laser techniques of sorting and grading for agricultural products. Lab: Light transmittance and reflectance properties of agricultural products. Interior characteristics of fruits and vegetables. Laser applications in: maturity and surface color, determination and detection of products defect. Milling degree of grain. Detection of surface defect biological material. Sorting and grading machines for agricultural products by laser technologies.

LABA 603 Laser in Animal and Crops Improvement (2 Cr. Hrs.)

Laser in animal breeding and improvement: technologies, quantitative genetics for animal breeding, benefits, and risks. Laser in animal improvement: animal traits improvement (fish, camel, and livestock, ... etc.). Improve of disease resistance, improve the nutritive value of low-quality feeds. Novel methods for improvement. Improvement of animal environment,...etc. Laser in crops breeding and improvement: advanced technologies for crop plant breeding, quantitative genetics for crop breeding. Breeding of biotic and abiotic stress plants. Heterosis. Mutation breeding. Crops improvement: improvement of plant resistance to stress. Improvement of quality and productivity in crops (examples),... etc.

LABA 604 Laser in Gene Technology for Agricultural Improvement (2 Cr. Hrs.)

Classical plant improvement methods, Overcoming crossability barriers, Genome and chromosome manipulation, Modern techniques in plant improvement, Gene mutation and knockout, Phenotypic analysis (quantitative trait loci (QTL). Metabolic analysis, Gene sequencing and new genes discovery. Gene manipulation to increase crops yields, quality, and resistance to environmental stress. Laser-based techniques for crop improvements.

LABA 605 Agricultural Bioinformatics and Biosafety (2 Cr. Hrs.)

Bioinformatics and its applications. Major online databases. Practical use of the database. DNA, RNA and proteins in bioinformatics. Similarity, homology, local and global sequence alignment. Pairwise alignment, Dot sequence alignment. BLAST, Types of BLAST and how to use BLAST. FASTA. ClustalW. Purpose. Biosafety in agriculture.

LABA 606 Techniques in Agricultural Biotechnology (2 Cr. Hrs.)

Techniques in agricultural biotechnology (introduction, principles, types and applications): Animal production techniques. Physiological techniques. Microbial techniques (PCR technique for virus and microbes detection). Biochemical techniques. Genetical techniques. Diagnostic techniques. Electrophoretic techniques. Microtechniques in agricultural biotechnology: (introduction, principle and applications). Microscopic techniques: phase contrast microscopy. Fluorescence microscopy. Atomic force microscopy. Confocal laser scanning microscopy, ...etc. Preparations of biological specimens for microscopic examination (fixation, staining, sectioning and squashing).



LABA 607 Laser Control in Agricultural Machines (2 Cr. Hrs.)

Introduction. Principles of Laser control in Agricultural Machines. Hydraulic system in farm machinery, Control Unit in Tillage and Sowing Equipment, Control Unit in Surveying and Leveling Machines, Pneumatic control in operating systems, Laser Remote sensing control for harvesting, Automation system in Post Harvest machine, Control unit in irrigation systems, Control unit in quality control.

LABA 608 Machine Vision of Agricultural Products (2 Cr. Hrs.)

Introduction. Digital image fundamentals. Image enhancement in the spatial domain. Image enhancement in the frequency domain. Image restoration. Color image processing. Wavelets and Multiresolution processing. Image compression. Morphological image processing. Image segmentation.

**III. Ph.D. Degree:-****A) Special Elective Courses (12 Cr. Hrs.) for the specialty of Laser Applications in Metrology (LAM)**

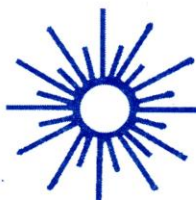
Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LAM 701	Advanced Laser Physics	3	3		
LAM 702	Quantum Optics	3	3		
LAM 703	Mathematical Physics	3	2	2	
LAM 704	Ultrafast Phenomena	3	3		
LAM 705	Theoretical Physical Problems	3	2	2	
LAM 706	Ionization Physics	3	3		

B) Special Elective Courses (12 Cr. Hrs.) for the specialty of Photochemistry and Photobiology (PP)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
PP 701	Light in Bioscience	2	2		
PP 702	Advanced Applications in Nanotechnology	2	2		
PP 703	Femtochemistry and Femtobiology	2	2		
PP 704	Research and Essay	2	2		
PP 705	Molecular Plasmonic	2	2		
PP 706	Bio-Photonics	2	2		
PP 707	Cellular Bio-imaging	2	2		

C) Special Elective Courses (12 Cr. Hrs.) for the specialty of Laser Applications in Biotechnology and Agriculture (LABA)

Course		Credit Hours (Cr. Hrs.)	Contact Hours		
Code	Course Name		Lecture	Exercise	Practical
LABA 701	Advanced Approaches in Agricultural Biotechnology	3	2		2
LABA 702	Laser Applications in Agricultural Engineering	3	2		2
LABA 703	Applications of Laser Spectroscopy in Agricultural Biotechnology	3	3		
LABA 704	Genetically Modified Crops and Animals	3	3		
LABA 705	Research Project	3	2		2
LABA 706	Laser and Nanotechnology in Soil and Water Treatment	3	3		
LABA 707	Laser in Quality Evaluation of Agricultural Products	3	3		



LAM 701 Advanced Laser Physics (3 Cr. Hrs.)

Investigation of physical processes involved in high power laser-plasma interactions with gasses and solids, phase conjugation of laser beams by non-linear absorption and photon scattering mechanisms, laser spectroscopy of ultra-trace quantities and single atom detection, laser-induced damage mechanisms; metal vapor white laser studies and its applications into holography.

LAM 702 Quantum Optics (3 Cr. Hrs.)

Dirac formulation of quantum mechanics. Elementary quantum systems. Operator Algebra. Quantization of electromagnetic field. Interaction of radiation with matter. Quantum theory of Damping Density operator methods. Quantum theory of damping Langevin approach. Lamb's semiclassical theory of laser. Statistical properties of a laser.

LAM 703 Mathematical Physics (3 Cr. Hrs.)

Complex variables. Laplace transformation. Fourier transformation. Special functions. Differential equations. Partial differential equations.

LAM 704 Ultrafast Phenomena (3 Cr. Hrs.)

Propagation and applications of ultrafast laser pulses (pico-, femto-, attosecond pulses) - Linear and nonlinear pulse shaping processes (such as optical solitons and pulse compression). Some laser principles (such as Single - and multimode laser dynamics, Q-switching, Active and passive mode locking). Different techniques of pulse characterization (such as Autocorrelation, FROG, SPIDER). Basics of laser amplifiers. Optical parametric amplifiers and oscillators. Some applications in research and industry.

LAM 705 Theoretical Physical Problems (3 Cr. Hrs.)

Problems connected with the experimental researches on laser induced breakdown phenomenon including interactions of coherent laser radiation with matter. Electron scattering in gasses. Electrical breakdown and electrical discharges in gasses with particular computer simulation. The theoretical foundation of statistical mechanics, isotropic homogeneous turbulence.

LAM 706 Ionization Physics (3 Cr. Hrs.)

Investigation of collision processes between electrons, ions, photons and gas atoms and molecules, fundamental mechanism of the electrical breakdown of gasses at high voltages and high electric field strengths under static and impulse voltages, vacuum breakdown, cross sections for low energy electron - atom and molecule collisions.

PP 701 Light in Bioscience (2 Cr. Hrs.)

This course includes advanced research in the field of biomedical applications under the following topics: UV-induced immunosuppression, UV and visible radiation effects and vision, Photo-chemotherapy technique *in vivo*.

PP 702 Advanced Applications in Nanotechnology (2 Cr. Hrs.)

This course deals with advanced topics in the field nanotechnology in the following topics: Hybrid Nanostructure (core-shell, doped nanomaterials and nanoalloys), Hybrid Nanocomposite (organic-inorganic hybrid and Graphene composite), Biomedical research applications (e.g. nano-drug delivery, biosensing), Industrial applications (smart paint, ceramic, cement, textile), Nanoelectronics (Nanodevices, thermoelectric devices), Energy (e.g. solar heater, energy saving, photovoltaics), Environmental applications (e.g. water purification, waste water remediation, water desalination), Ethical aspects of nanotechnology (Environment impact, hazard risk).



PP 703 Femtochemistry and Femtobiology (2 Cr. Hrs.)

Basic principles of femtosecond spectroscopy, experimental techniques: time resolved spectroscopy, ultrafast primary processes in some biological systems: protein dynamics, protein, electron transfer, folding and defolding biological reaction, Femtosecond Chemistry: the concept of transition state probing and applications, Solvation dynamics, Femtosecond dynamics of Acid-base reaction & Isomerization reaction, ultrafast processes in nanostructured materials, (clusters, plasmonic & semiconductor quantum dots), Applications: optical switch, photosynthesis, photocatalysis, photodynamics and photothermal.

PP 704 Research and Essay (2 Cr. Hrs.)

During the course, participants will study scientific papers and give a presentation about it on the final day. Also, they will write an essay to summarize the studied research papers. Participants will contribute to an open discussion to answer questions come out the presented research.

PP 705 Molecular Plasmonic (2 Cr. Hrs.)

Fundamentals of plasmonics, localized surface plasmon, plasmon-plasmon coupling, laser-particle interactions, theories and techniques of surface enhanced Raman scattering (SERS). Metal Enhanced Fluorescence (MEF). Applications of plasmonic nanoparticles.

PP 706 Bio-Photonics (2 Cr. Hrs.)

Biophotonics: a new frontier, bioimaging: principles and techniques; optical biosensors, flow-cytometry, optical tweezers and scissors, biomaterials for photonics, tissue engineering with light, biomedical applications.

PP 707 Cellular Bio-imaging (2 Cr. Hrs.)

Interaction of light with tissue, Types of bioimaging , Applications of bioimaging, Optical Biosensors and ultrahigh resolution optical microscopy, Experimental aspects of Nanoparticles and Quantum Dots in imaging, Applications of fluorescence and bioluminescent imaging.

LABA 701 Advanced Approaches in Agricultural Biotechnology (3 Cr. Hrs.)

Introduction. Specific pathogen free plant production. Synthetic seeds. Plant secondary metabolites. Novel proteins and vaccines technologies. Genes and diseases. New diagnostics in animal production. New technologies in animal production, breeding and improvement. DNA polymorphism (principles and applications). Cloning (principles and applications). Biofilms, biosensors and biochips technologies. Genomics, proteomics, metabolomics and nutrigenomics. Real-time PCR applications. Blotting Systems (techniques and applications). ELISA techniques for detection of gene expression. Laser application in each field.

LABA 702 Laser Applications in Agricultural Engineering (3 Cr. Hrs.)

Farm machinery and equipment, Tillage and Sowing Equipment, laser machine control system, Laser in surveying; land leveling using laser, Drainage machines using laser, Sowing operations using laser; harvesting Engineering using laser, sorting and grading machines by laser, Storage and Packaging Technology, Solar and Wind Energy Engineering, Renewable energy and agricultural applications.

LABA 703 Applications of Laser Spectroscopy in Agricultural Biotechnology (3 Cr. Hrs.)

Introduction. Laser Spectroscopic applications in Farm animal biotechnology (productivity, reproductively and diagnostic applications and others). Microbial Biotechnology (pathogen - host relationship applications and others). Crops Biotechnology (physiological, biochemical and genetical applications and others).



LABA 704 Genetically Modified Crops and Animals (3 Cr. Hrs.)

Introduction and principals. Methods of gene delivery (gene gun, electroporation, Agrobacterium system, microinjection, lipofectin....etc.). Laser photoporation methods. Advantages and disadvantages of each method. Genetically modified farm animals: examples, applications, benefits and policy. Genetically modified crops, most transgenics are crops and plants: examples (as Golden Rice for producing more vitamin A. and stress resistant transgenic crops) applications, benefits and policy. Safely engineered food,...etc. Laser application in each field.

LABA 705 Research Project (3 Cr. Hrs.)

Students meet their advisor for discussion and project management. Seminar and review of literatures in topics related to elective courses and specialty. The students for groups and select topics according to their field of interest and background.

LABA 706 Laser and Nanotechnology in Soil and Water Treatment (3 Cr. Hrs.)

Introduction to Nanomaterials; Fundamental of water and soil, Physical characteristics of soil and water, Water and land resources, Water supply and treatment systems by nanoparticles, Soil conservation and water harvesting, Water quality standards, Water and soil pollution. Irrigation and drainage engineering, Drip and sprinkler irrigation technology; Fertilizer application and weed management practices.

LABA 707 Laser in Quality Evaluation of Agricultural Products (3 Cr. Hrs.)

Introduction of light interaction with agricultural material, Quality factors in fruit and vegetable, Maturity indices for harvesting of horticultural crops, Evaluation of food liquid, Quality evaluation of food using laser, Quality control of agricultural production, Image System for quality evaluation of agricultural products, Radiation of quality preservation of agricultural material, Food safety.



NATIONAL INSTITUTE OF LASER ENHANCED SCIENCES

N. I. L. E. S
Cairo University



جامعة القاهرة

اللائحة الداخلية للدراسات العليا (٢٠١٦م)

المعهد القومي لعلوم الليزر

Department of Engineering Applications of Lasers (EAL)



Department of Engineering Applications of Lasers (EAL)

Department of Engineering Applications of Lasers (EAL) offers the candidates the opportunity to study for the Diploma, M.Sc. Degree and Ph.D. Degree in the specialty of Engineering Applications of Lasers.

I. Diploma:-

A) Main Courses (18 Cr. Hrs.)

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
EAL 501	Laser Physics I	3	2	2		
EAL 502	Fundamentals of Optics	3	2	2		
EAL 503	Optoelectronics	3	2	2		
EAL 504	Optics Laboratory	2	1		2	
EAL 505	Laser Spectroscopy	2	1	2		
EAL 506	Optical Instrumentation	2	1	2		
EAL 507	Laser Safety	1	1			
EAL 508	Applied Project	2			4	EAL 501, EAL 504, EAL 507

B) Elective Courses (6 Cr. Hrs.)

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
EAL 509	Computational Techniques	2	1	2		
EAL 510	Digital Image Processing	2	1	2		
EAL 511	Semiconductor Laser Fabrication	2	1		2	EAL 501, EAL 502, EAL 503
EAL 512	Modern Optics	2	1		2	EAL 502
EAL 513	Laser Applications in Electrical and Electronics Engineering	2	1		2	EAL 501, EAL 502, EAL 503
EAL 514	Laser Applications in Bio-Medical Engineering	2	1		2	EAL 501, EAL 502, EAL 503
EAL 515	Laser Applications in Mechanical Engineering	2	1		2	EAL 501, EAL 502, EAL 503



EAL 501 Laser Physics I (3 Cr. Hrs.)

Introduction of the physics of energy levels of different media, dispersion, absorption, and emission. Natural, collisional and Doppler broadening. Gaussian beam. Rate equations for three and four level lasers. Stability conditions of laser operation in different cavity configurations, transversal and longitudinal mode. Laser mode oscillation, gain threshold and gain saturation. Laser output power and frequency, tuning and single frequency operation. Specific lasers and pumping mechanisms.

EAL 502 Fundamentals of Optics (3 Cr. Hrs.)

Geometrical Optics: Reflection, Refraction, Matrix Optics, Spherical surfaces, Plan surfaces, Lenses and Mirrors. Cardinal points of lenses. Chromatic and spherical aberrations. Analysis of optical systems and correction to aberration Physical Optics: Interference, diffraction, wave equation, polarization in different media. Jones polarization representation of light, and different polarization devices (QWP, HWP, PBS).

EAL 503 Optoelectronics (3 Cr. Hrs.)

Semiconductor physics. P-N junction. Light-emitting diode. Semiconductor Light Amplifier. Semiconductor lasers diode. Specialized laser diodes; multiple quantum well, quantum dot, distributed feedback, Vertical Cavity Surface Emitting Lasers. Semiconductor photodetectors. Optocouplers. Optical and optoelectronic integrated circuits. Noise in semiconductor devices. Stark, Raman, Zeeman, Pockels, Kerr and Faraday effects.

EAL 504 Optics Laboratory (2 Cr. Hrs.)

Experimental study of optical systems together with various engineering applications. Some experiments can be developed according to the student's background.

EAL 505 Laser Spectroscopy (2 Cr. Hrs.)

Introduction to the theory and practice of laser spectroscopy as applied to atomic and molecular systems. Fundamentals of spectroscopy, lasers and spectroscopic light sources, high resolution and time resolved laser spectroscopy with applications in atmosphere, chemistry, environmental science and medicine.

EAL 506 Optical Instrumentation (2 Cr. Hrs.)

Microscopes, telescopes, Fabry-Perot etalons. Different Types of interferometers. Spectrometers, spectrographs and monochromators. Electro-optic modulators. Acoustic-optic modulators. Optical Fiber sensors. Beam shaping.

EAL 507 Laser Safety (1 Cr. Hr.)

Laser characteristics, Laser classifications. Laser tissue interaction. Laser hazards. International Standards, Control measures, Safety regulations.

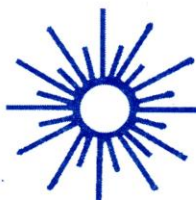
EAL 508 Applied Project (2 Cr. Hrs.)

Prerequisite: EAL 501 - EAL 504 - EAL 507

Design and realization of different laser systems according to student specialty. It is a capstone project. The students form groups and select a topic according to their field of interest. The project must address practical problems related to engineering and technological application. The project is completed in two phases; the first phase covers the study and design, the second covers the implementation of the design.

EAL 509 Computational Techniques (2 Cr. Hrs.)

Numerical techniques for solving linear and nonlinear systems of equations. Numerical solutions of ODE and PDE. Extrapolation and Interpolation. Curve fitting and smoothing. Programming of some applications in laser engineering.



EAL 510 Digital Image Processing (2 Cr. Hrs.)

Overview of the digital image processing techniques and applications, image sampling, enhancement, restoration, compression, analysis, spatial domain and frequency domain filtering, color image processing and morphological image processing.

EAL 511 Semiconductor Laser Fabrication (2 Cr. Hrs.)

Prerequisite: EAL 501 - EAL 502 – EAL 503

General Introduction to fabrication and Clean Room. Doping of P junction, and N junction using diffusion technique. Doping of P junction, and N junction using Liquid phase epitaxy LPE and Metal Organic Chemical Vapor Deposition MOCVD technique. Growing an P-N junction. Growing an N-P-N junction. Growth techniques for monocrystal layer. Application of the growth techniques to the fabrication of Light Emitting Diodes, and Lasers.

EAL 512 Modern Optics (2 Cr. Hrs.)

Prerequisite: EAL 502

Fourier Optics: Fourier Analysis, Convolution Theory, Fourier transforming in lens systems, Frequency analysis of imaging systems, Coherent and incoherent imaging, Spatial filtering and optical information processing

Holography: Theory of holography. Types of holograms. Single-wavelength hologram. Multi-wavelength hologram. Digital hologram. Recording media; Photorefractive materials, Spatial light modulators. Holographic measurements. Holographic applications.

EAL 513 Lasers Applications in Electrical and Electronics Engineering (2 Cr. Hrs.)

Prerequisite: EAL 501 - EAL 502 – EAL 503

Laser applications in information technology; Optical storage, CD, DVD, blu-ray, holographic optical storage, Display systems: Spatial light modulators, 2D-3D laser printing.

Laser applications in Optical communication; optical fibers: types, attenuation, dispersion, chirp. Transmitter and receivers. Modulation techniques. Concept of All-optical communication systems.

Laser applications in metrology and remote sensing.

EAL 514 Lasers Applications in Bio-Medical Engineering (2 Cr. Hrs.)

Prerequisite: EAL 501 - EAL 502 – EAL 503

Laser-tissue interaction. Biomedical lasers devices. Laser applications biomedical engineering. Laser Applications in Ophthalmology. Laser Applications in Dermatology. Laser Applications in Dentistry. Laser Applications in Surgery. Other applications in biomedical engineering.

EAL 515 Lasers Applications in Mechanical Engineering (2 Cr. Hrs.)

Prerequisite: EAL 501 - EAL 502 – EAL 503

Basic concept of Laser Material Interaction, Laser separation techniques include cutting, drilling, material removal and marking by ablation (engraving), Laser Joining (Welding, Soldering), Laser Surface treatment (Laser hardening, Laser melting, Laser alloying, Laser Cladding), Laser Marking, Laser forming and Laser Cleaning.

**II. M.Sc. Degree:-****A) Main Courses (8 Cr. Hrs.)**

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
EAL 601	Laser Physics II	3	2	2		EAL 501
EAL 602	Advanced Optics	2	1	2		EAL 502
EAL 603	Nonlinear Optics	2	2			EAL 602
EAL 604	Laser Laboratory	1			2	

B) Elective Courses (4 Cr. Hrs.)

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
EAL 605	Quantum Electronics	2	1	2		EAL 601
EAL 606	Molecular Spectroscopy	2	2			
EAL 607	Selected Topics in Optical Fibers	2	1	2		
EAL 608	Optical Communication Systems	2	1	2		
EAL 609	Laser Material Processing	2	1	2		
EAL 610	Laser Diagnostics in Mechanical Engineering	2	1	2		
EAL 611	Selected Topics in Bio-Medical Engineering	2	1	2		

EAL 601 Laser Physics II (3 Cr. Hrs.)**Prerequisite: EAL 501**

Laser pulsed operation, relaxation oscillation and spiking, laser amplifiers techniques, gain switching, cavity dumping, Q-switching, mode locking. Laser modes and optical resonators. Pico and Femtosecond lasers and their applications. Pulse stretching and shortening. Regenerative amplifiers. Chirp pulse amplifiers.

EAL 602 Advanced Optics (2 Cr. Hrs.)**Prerequisite: EAL 502**

Beam optics. Resonator optics. Dielectric optical waveguides. Coupled mode theory. Photonic Integrated optics. Photonic crystals, metamaterials. Advanced laser-based systems.

EAL 603 Nonlinear Optics (2 Cr. Hrs.)**Prerequisite: EAL 602**

Nonlinear susceptibility. Nonlinear properties of crystals and isotropic materials. Second harmonic generation. Phase matching. Three-wave mixing. Four-wave mixing. Parametric amplification and oscillation. Phase conjugation. Self-focusing and soliton propagation. Optical bistability. Photonic switching and computation.



EAL 604 Laser Laboratory (1 Cr. Hr.)

Experimental study of laser systems together with various engineering applications.

EAL 605 Quantum Electronics (2 Cr. Hrs.)

Prerequisite: EAL 601

Review of wave mechanics. Schrodinger equation of free particle, average value, Ehrenfest theorem, time independent Schrodinger equation. Uncertainty relation between momentum and position of a particle, particle in a Coulombic potential, Hydrogen atom, quantum number. Radiation and atomic system, Interactions between atoms and radiation, open quantum mechanical systems, the density matrix, radiation in a cavity, modes of oscillation in an enclosed cavity, blackbody radiation into a single transverse mode, number of photons emitted by a blackbody into a quantum state.

EAL 606 Molecular Spectroscopy (2 Cr. Hrs.)

Introduction to group theory. Atomic oscillation in molecules. Modes of oscillation. Rotation and vibration modes. Selection rules. Electronic spectroscopy. Raman spectroscopy. Raman laser.

EAL 607 Selected Topics in Optical Fibers (2 Cr. Hrs.)

Review of optical fibers characteristics and types. Modes and mode propagation. Modal effects, absorption and scattering. Polarization effects in optical fibers. Nonlinear effects in optical fibers. Earth-doped fibers EDF. Fiber amplifiers. Fiber lasers. Photonic crystal fibers.

EAL 608 Optical Communication Systems (2 Cr. Hrs.)

Fiber optic communications. Free space optical communications. Optical transmitters and receivers. Power budget. System design and performance. Digital systems. Analog systems. Soliton communication system. WDM and filters. Multichannel optical communications. Optical networks. All-optical communication systems.

EAL 609 Laser Material Processing (2 Cr. Hrs.)

Types of industrial lasers. Laser material interaction. Heat flow theory. Laser material processing involving no phase change (laser hardening, laser shocking penning, laser bending or formation). Laser material processing involving phase change (laser melting, Laser welding, laser cutting, laser deposition, laser joining, laser cleaning).

EAL 610 Laser Diagnostics in Mechanical Engineering (2 Cr. Hrs.)

Review of combustion and fluid mechanics. Introduction to laser diagnostics for fluid dynamics. Introduction to laser diagnostic for combustion (flow field, temperature and species).

EAL 611 Selected Topics in Bio-Medical Engineering (2 Cr. Hrs.)

Light propagation in biological tissues. Tissue optical properties with strong (multiple) scattering. Fundamentals of optical instrumentation and imaging systems for biomedical microscopy, spectroscopy, and bioanalytical techniques, phototherapy (photodynamic therapy and low level laser therapy). Methods and algorithms for the measurements of the optical parameters of tissue.

**III. Ph.D. Degree:-****A) Elective Courses (12 Cr. Hrs.)**

Course		Credit Hours (Cr. Hrs.)	Contact hours			Pre-requisite
Code	Course Name		Lecture	Exercise	Practical	
EAL 701	Laser Physics III	3	3			EAL 601
EAL 702	Quantum Photonics	3	3			
EAL 703	Laser Technology	3	3			
EAL 704	Nano-Photonics	3	3			
EAL 705	Ultrafast Phenomena	3	3			
EAL 706	Semiconductor Laser Physics	3	3			
EAL 707	Electronic Spectroscopy	3	3			
EAL 708	Advanced Measurement Techniques	3	2	2		
EAL 709	Advanced Optical Communication and Networks	3	3			
EAL 710	Advanced Imaging Techniques	3	3			
EAL 711	Pattern Recognition	3	2	2		
EAL 712	Advanced Laser Material Processing Techniques	3	3			
EAL 713	Advanced Laser Diagnostics in Combustion and Fluid Mechanics Engineering	3	2	2		
EAL 714	Laser Technology Equipment	3	2		2	
EAL 715	Heat Distribution and Cooling for Laser Systems	3	3			

EAL 701 Laser Physics III (3 Cr. Hrs.)**Prerequisite: EAL 601**

Introduction to Electron Photon, electron phonon, interaction (semi-classical and quantum) applied to spontaneous and stimulated emission. Quantum study of spontaneous emission and stimulated emission, Raman laser quantum study, Free electron laser theory and design. Noise in Lasers.

EAL 702 Quantum Photonics (3 Cr. Hrs.)

Concepts of second quantization, photonic phenomena; solitons, optical bistability, entanglement and others. Some applications like quantum communication, quantum cryptology, laser cooling of atoms and others.



EAL 703 Laser Technology (3 Cr. Hrs.)

Laser crystal growth, Gas laser technology, Gas laser mechanical and electronic criteria in fabrication, semiconductor laser fabrication, laser measuring equipment design and study.

EAL 704 Nano-Photonics (3 Cr. Hrs.)

Light matter interactions at nanoscale as well as applications of Photonics for nanotechnology and nanobiotechnology. Important technological advances in industries as diverse as microelectronics, optoelectronics, magnetic recording, biomedicine, environmental remediation and homeland security.

EAL 705 Ultrafast Phenomena (3 Cr. Hrs.)

The generation, propagation and applications of ultra short pulses (nano-, pico-, femto-, attosecond pulses). The linear and nonlinear pulse shaping processes (such as Optical solitons and Pulse compression). Review of some laser principles (such as Single- and multi-mode laser dynamics, Q-switching, Active and passive mode-locking). Different techniques of pulse characterization (such as Autocorrelation, FROG, SPIDER). Basics of ultrafast laser amplifiers, optical parametric amplifiers, and oscillators.

EAL 706 Semiconductor Laser Physics (3 Cr. Hrs.)

Band gap engineering and energy level engineering based on selection rule and K-selection rule, Application to atomic, molecular and semiconductor laser. Electron Photon, electron phonon, interaction applied to spontaneous and stimulated emission. Semiconductor laser (planar, VCSEL). Laterally coupled semiconductor lasers. Noise study in semiconductor lasers.

EAL 707 Electronic Spectroscopy (3 Cr. Hrs.)

Bragg-Von Laue scattering. Energy bands in solids. Brillouin zones in 3-D. Schrodinger equation and its solution. Spin and double groups. Fermi selection rules.

EAL 708 Advanced Measurement Techniques (3 Cr. Hrs.)

Laser in metrology, Distance measurement, Holography, Laser in high speed photography, laser in range finding, Optical sensors, laser remote sensing, Heterodyne measurement (distance-spectroscopy), laser frequency stabilization, Optical interferometry.

EAL 709 Advanced Optical Communication and Networks (3 Cr. Hrs.)

Advanced technologies in optical transmission system. Chromatic dispersion compensation, Polarization mode dispersion compensation and nonlinearity management. Advanced modulation/demodulation formats. Multilevel modulations coding. Optical networking Design of high-speed and high-capacity optical transmission links, routing and distribution.

EAL 710 Advanced Imaging Techniques (3 Cr. Hrs.)

Radiative transfer equation and diffusion theory, ballistic imaging and microscopy, optical coherence tomography, diffuse optical tomography, photo-acoustic tomography, ultrasound-modulated optical tomography.

EAL 711 Pattern Recognition (3 Cr. Hrs.)

Overview, basics, concepts and various approaches of statistical pattern recognition, parametric and non-parametric approaches, feature extraction method and methods of structural pattern recognition.



EAL 712 Advanced Laser Material Processing Techniques (3 Cr. Hrs.)

Interaction of pulsed laser radiation with material. Pulsed surface plasma. Physics of damage and deep melting of metals by laser pulses. Interaction of repetitively pulsed laser radiation with material.

EAL 713 Advanced Laser Diagnostics in Combustion and Fluid Mechanics Engineering (3 Cr. Hrs.)

Experimental Techniques: Laser diagnostics in combustion and fluid mechanics using Particle Image Velocimetry (PIV), Laser Doppler Velocimetry (LDV), Laser Induced Breakdown Spectroscopy (LIBS), Laser Induced Fluorescence (LIF), Rayleigh scattering and Raman spectroscopy. Computational Technique: combustion and fluid mechanics using (ANSYS, COMSOL, etc).

EAL 714 Laser Technology Equipment (3 Cr. Hrs.)

The design and manufacture of Vacuum pump system for vacuum technology (theory + experimental). The design and manufacture of vacuum coating systems (theory + experiment). The design and manufacture of diffusion and phase epitaxy equipment (theory + experiment). The design and manufacture of (MOCVD metal organic chemical vapor deposition systems), and (Molecular Beam Epitaxy systems) (theory). Laser packaging techniques.

EAL 715 Heat Distribution and Cooling for Laser Systems (3 Cr. Hrs.)

Study and design of heat transfer inside different laser types and materials. Study and design of cooling systems for different laser systems.