Laser in medicine

Course Book – (4th Year Physics– medical Branch)

Lecturer's name ***M.Sc eman abdulmajed saied***

Academic Year: 2022/2023

Course Book

1-Course Name	Laser in Medicine
2-Lecturer in charge	MSc eman abdulmajed saied
3-Department/ College	E-mail: eman.saied@su.edu.krd Website: https://academics.su.edu.krd/eman.saied
4-Contact	Theory: 3.0 (There only) Practical: 2
5-Time(In hours) per week	Theory: 3.0 (There only) Practical: 2
6-Office Hours	At least 30 h/week
7- Course Code	N/A
8- Teacher's academic profile	MSc Salahaddin university , laser physics, *2012* Thesis: "Evidence of AlxSiyOz formation during preparation of aluminum oxide film on the silicon substrate using glass assisted CO_2 laser method" BSc Salahaddin University, physics science , *2007* Graduated v.good *Journal paper* **-E.A.saied ,Y.M.Hassan "Characterization of aluminum oxide films on p-type silicon substrate prepared by glass assisted CO_2 laser technique," Indian J Phys (January 2014) 88(1):43–47.** **-E. A. Saied, M. M. Ismahil & Y. M. Hassan ''Laser Irradiation and Temperature Annealing of CuO–Cu2O Complex Thin Films'' Arabian Journal for Science and Engineering volume 45, pages4921–4927(2020).** **-Mahira Ismael, Eman Saied & Yousif M. Hassan ''Laser-Assisted Spin Coating of Al-Doped ZnO thin Films''Journal of Russian Laser Research volume 41, pages149–155(2020).** I was appointed as an assistant lecturer at department of physics/Salahaddin Erbil University. I have taught a wide range of subjects, at undergraduate level, including **Laser and Fiber optic** [for academic year 2013-2014 and 2014-2015 for fourth year Physics student in Physic department(communication branch)] , **Electricity lab, Thermodynamic lab ,Nuclear lab, General physics, Medical physics lab, Optic lab ,Laser lab**
9- Keywords	Laser, laser interaction with solid, thin film preparation by laser.

10- Course Overview:

This module introduces Laser physics and emphasizes its roles in medicine especially in the treatment of cancer, Skin, et.

The course starts with a review of the basic physics of optical cavities and the spontaneous/stimulated emission from materials leading to laser amplifiers and oscillators. Examples of atomic, ionic and molecular gas lasers are presented including systems for continuous wave and pulsed beam operation. The optical properties of laser cavities, and the optics of Gaussian beam are discussed.

The course starts with a description of the relevant physical interactions between laser and tissues, together with an explanation of the various parameters that can be used to quantify these interactions and how they relate to the physical properties of the tissues. This is followed by a description of three different mathematical techniques that can be used to calculate light distribution both within and at the surfaces of tissues, using the previously defined parameters as a starting point. The lectures are supplemented with some demonstrations of the effects of light distribution in scattering and absorbing media and by tutorial sessions where some aspects of the mathematical derivations are reiterated and examples of calculations similar to those in the examination are worked through. The design and working principles of the types of laser most often used in medicine and surgery are considered in some detail, particular emphasis being given to the carbon dioxide, neodymium: YAG and tunable dye lasers. Similar emphasis is given to the design and working principles of the light delivery systems used with these different types of laser, namely the articulated arm and step index optical fibres. The statistics mentioned above will also help to understand and analyze the Paramagnetism and Diamagnetism of solids.

Following this introduction to the physical concepts, basic theory and working principles of lasers and laser light delivery systems, the student's attention is now turned to the effects laser light can have on tissues, namely: the photothermal, photochemical, photomechanical and photoablative effects. To set these in an appropriate context, a lecture at this point in the course is devoted to an introduction to the therapeutic applications of laser light. The lecture takes the form of a slide show showing the various surgical uses of lasers and is used to help demonstrate how the unique properties of laser light can lead to the production of a very wide range of different tissue effects including the ablation and coagulation of soft tissues, the treatment of cancers and the fragmentation of urinary and biliary calculi. Of particular importance is the depth to which soft tissues are coagulated beneath a carbon dioxide laser ablation crater, since this defines the degree of haemostasis and the time it takes for the laser wound to heal. Theoretical models are therefore presented to help calculate thermal coagulation depths. These models take the form of fairly simple analyses of heat diffusion or, In the last part of the subject in this course, The laser safety part of the course consists of introducing the definitions of irradiance and radiance as optical measurement parameters. A largely qualitative section related to the physical and anatomical reasons and experimental measurements that underpin American National Standards Institute (ANSI). Finally, a summary of the standards themselves is presented with enough information provided to allow the calculation of a number of laser safety scenarios.

11- Course Objective:

The course will give students a better understanding of a number of lasers topics, the followings are examples

- Introduction to principle of lasers and physical basics of laser
- Describe structure and operating principle of laser (semiconductor, gas and solid-state laser).
- Describe physical mechanism of interaction of laser beam with Tissue.
- To provide a sound basic knowledge and understanding of the optical properties of tissues, the effects of multiple scattering on light distribution and mathematical methods for calculating the transport of light in tissues.
- To impart knowledge in laser physics and the principles of the thermal, photochemical and photomechanical effects that light can have on biological tissue.
- Classify the hazards connected with unprofessional handling of lasers or laser devices.
- Describe some medical procedures in terms of the physics of interaction of laser light with an irradiated object.

- Analyze the effects of light interaction with matter.
- Mechanism of interaction of laser radiation with living things and inanimate matter.
- Safe handling of laser equipment.
- Some examples of use of lasers in medical diagnosis and therapy.
- List the safety aspects and concerns of cutaneous laser systems.

12- Student's obligation

Normally, students obliged to attend all the lectures and take notes during the lecture. In addition, in class participation would be a bonus of the students to widen their knowledge and understand the module thoroughly.
Attending the lectures regularly would be a crucial point for the students to consider, because the module is very new and very detailed. If the students missed few lectures, they would have difficulty to get back on the track.
Additionally, students are ought to submit and their home works and assignments given by their lecturer, because there would be penalties for the late submission. All exams and tests done with books closed, and, students have to take at least one compulsory exams with few class test and quizzes during the years of study.
During this year the student must be report a patient which treated by laser in hospital and laser center.

13- Forms Of Teaching

Different forms of teaching will be used to reach the objectives of the course: power point presentations for the lectures including head titles and definitions and summary of conclusions, classification of materials and any other illustrations. There will be classroom discussions and the lecture will give enough background to solve, analyze, and evaluate problems sets, and different issues discussed throughout the course. in addition to the white board (Students should be use course references).

14- Assessment scheme

All exams have 30 marks, full report has(5 marks)(During this year the student must be report on laser application in medicine), Knowledge of assigned readings, satisfactory completion of short assignments, class participation, and in-class work will constitute (5 Marks). So that the final grade will be based upon the following criteria: Semester examinations Mid- semester exam: 15%+15%=30%
Classroom participation and assignments: 5%+ Report: 5% =10%
Final Exam: 60% .

15- Student Learning Outcome:

Students who took the module of Laser In Medicine would easily be able to find a job in the Laser department in the Laser centers. The students would be taught the process of Laser, and what happens to the patient from the consultation time till the follow up process

16- Course Reading list and References:

The main text books are:

1. *Orazio Svelto, David C. Hanna, "Principles of Lasers" Springer New York Dordrecht Heidelberg London, 2010.*
2. *B.hitiz ,J.Ewing ,Jeff Hech," Introduction to laser technology (3rd edition)2001new yourk .*
3. *Ronald W. Waynant" LASERS IN MEDICINE"United States of America,2002.*
4. *Markolf H. Niemz"biological and medical physics, biomedical engineering" University of Heidelberg,Springer ,2007*
5. *Laser-Tissue Interactions, by Rudolf Steiner*
6. *Lasers for medical applications(Diagnostics, therapy and surgery), by Helena Jelínková 2013*

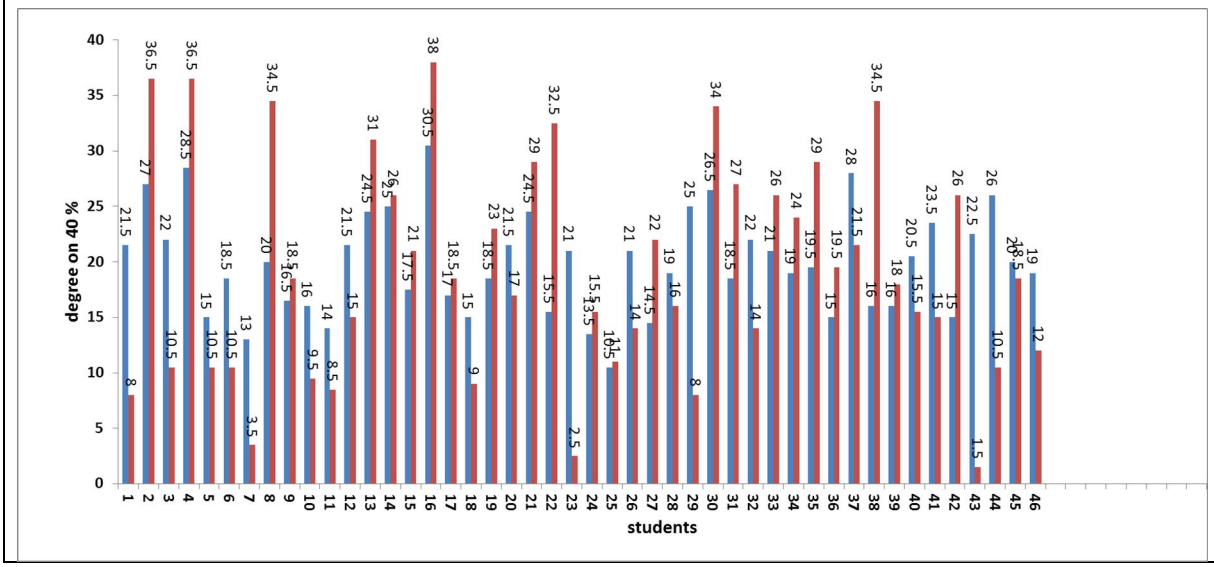
7. *Basics of Laser Physics (For Students of Science and Engineering), by Karl F. Renk 2017.*

17- The Topics	Lecture's Name
Week (1,2,3) Principle of Laser Physics **Spontaneous and Stimulated Emission, Absorption .** **The Laser Idea ,. Pumping Schemes , Properties of Laser Beams , Monochromaticity , Coherence , Directionality . . Brightness ,. Short Time Duration , Types of Lasers** **,Common Components of all Lasers , Einsteins Theory of light-matter interaction, Population inversion ,Energy Levels, Radiative and Nonradiative Transitions in Molecules and Semiconductors**	***MSc Eman abdulmajed saied***
(Week 4)Pumping Processes	
(Week 5)Resonator	
(week 6,7,8) **Active medium** **Three level system,Four level system,** **.pumping source, types of pumping source** **.Resonators** **.plane parallel (Fabry-Perrot)resonators** **.Stable resonator** **.Unstable resonator.** **Resonator modes** **Bandwidth of laser beam.** **Reducing bandwidth of laser beam**	
Week(9,10,11) **laser types based on mode of operation** **continues wave laser system** **pulsed laser system** **.A- Q. switching** **.B- mode locking** **C- cavity damping**	
Week(12.13,14) **laser types based on resonator state** **solid state laser .** **liquid laser.** **Gas laser .** **laser types based on emission range** **far infrared lasers** **mid infrared lasers** **visible laser** **ultra violet laser**	
Week(15)Laser-Tissue Intractons ,Interaction Mechanisms **Photochemical Interaction, Photodynamic Therapy and Biostimulation**	
Week(16,17,18)Laser-Tissue Intractons ,Interaction Mechanisms , **Thermal Interaction, Heat Generation , Heat Generation, Heat Transport ,**	

Heat Effects ., Laser-Induced Interstitial Thermotherapy (LITT) ,Summary of Thermal Interaction . . . . . .
Week (19)Laser-Tissue Intractons ,Interaction Mechanisms , Photoablation and Model of Photoablation , Cytotoxicity of UV Radiation ,Summary of Photoablation
Week (20) Laser-Tissue Intractons ,Interaction Mechanisms , Plasma-Induced Ablation ,Model of Plasma-Induced Ablation , Analysis of Plasma Parameters , Summary of Plasma-Induced Ablation
Week (21,22)Uses and Effects of Ultraviolet Laser on Cells and Tissues
week(22-25)Medical Applications of Lasers. . Lasers in Ophthalmology Lasers in Dentistry ,Lasers in Gynecology . . Lasers in Urology, Lasers in Neurosurgery , Lasers in Angioplasty and Cardiology, Lasers in Dermatology Lasers in Orthopedics , Lasers in Gastroenterology, Lasers in Otorhinolaryngology and Pulmonology
Week(26,27) Introduction to laser safety, Laser Hazards. Eye Hazards , Skin Hazards ,Associated Hazards from High Power Lasers , Laser Safety Standards and Hazard Classification ,Viewing Laser Radiation and Eye Protection
Week(28)Principles of Laser diode(Semiconductor Lasers from Visible to IR range) and its Applications in medicine
week(29,30) Non linear optics, Fiber optics

18-Practical Topics (if there is any)

19. Examinations: chat show results exam on 40%



20. Extra notes:
21. Peer review **ڵ هاوه ی وه پێداچوونه**