

Ministry of Higher Education and Scientific research



**Department of Physics**

**College of science**

**University of salahaddin**

**Subject course book : **Medical Optics****

**Course Book 3<sup>rd</sup> stage**

**Lecturer's: **Dr. Shaida Anwer Kakil****

**Academic Year: 2023/2024**

## Course Book

<b>1. Course name</b>	<b>Medical Optics</b>
<b>2. Lecturer in charge</b>	<b>Dr.Shaida Anwer kakil</b>
<b>3. Department/ College</b>	<b>Physics /science</b>
<b>4. Contact</b>	<b>e-mail: Shaida Anwer kakil Tel: (optional)</b>
<b>5. Time (in hours) per week</b>	<b>Theoretical :3</b>
<b>6. Office hours</b>	<b>All days(9Am-3Pm)</b>
<b>7. Course code</b>	
<b>8. Teacher's academic profile</b>	<ul style="list-style-type: none"> <li>- I awarded B.Sc. in physics (College of Science) in 2011 Salahaddin University.</li> <li>- M.Sc. in 2014-2015 (College of Science).</li> <li>-Lecturer from 2018</li> <li><b>Ph.D in 2020-2021</b> ( Salahaddin University-Erbil, through the split-site program with Universiti Milan-Italy.)</li> </ul>
<b>9. Keywords</b>	<b>Medical Optics ,Lens, mirror, interference, diffraction ,polarization, fiber optics</b>
<p><b>10. Course overview:</b> The branch of physics that concerns the applications of physics to medicine is called medical physics.</p> <p>The goal of studying optics is to teach students basic concepts about the light , electromagnetic wave , optical instruments used in the interpretation of the qualities of light and image formation and visual processing defects as a geometrical optics in addition to the physical optics which includes the study of the wave equation and the principle of superposition to be the entrance to the study of wave characteristics of light such as polarization, interference tissue optical properties , fibres optics and its application in medical , the student can keep place with technological development nowadays . also tissue optical properties.</p> <p>Optics has, since ancient times, being used as aid for the examination of human patients and in some therapeutic treatments. Many of the optic medical instruments in use today were developed in the nineteenth century and, with the advent of optical fibers and laser light sources in the mid twentieth century, a new generation of medical devices, instruments, and techniques have been developed that have helped modernize medicine and perform task unimaginable only a few decades ago. This chapter illustrates—through several optical instrument and application examples—the uses, benefits, and future</p>	

prospects that optics brings as an enabling technology to the medicine and the overall healthcare industry.

### 11. Course objective:

- The student will understand the nature of light and the light refracted and reflected from surface and how to image formed by lenses and mirror.
- The student will understand the theory of working various optical instruments, including the concept of how virtual images formed by it.
- the student will understand how eye work as camera and the refracted error of the eye and its correction with eyeglasses.
- The student will be able to explain the principles of wave motion, including the Principle of Superposition and the results of the waves interfere.
- The student will explain the physics of Diffraction form single and multiple slits and the Fresnel, Fraunhofer diffraction.
  - The student will understand the polarization of light.
  - The student will understand the principle of fiber optics and its application in medicine also the optical properties of tissues.
  - The student will understand fibre optics and its application in medicine .
  - **Lens types**, materials, and coatings all affect how you see through your glasses. Learn which **type** of **lens** you might need and how it can help your vision
  - 
  - **o Study about** The optical properties of the tissues and the interactions of light with tissues. The instrumentation and components in Medical Optics. The Medical Lasers and their applications The optical diagnostic applications The emerging optical diagnostic and therapeutic techniques
  - The modern use of light in medicine began in the nineteenth century, with rapid improvements in the understanding of both the physical nature of light and fundamental light-matter interactions.

### 12. Student's obligation

- The students should have presence in all lectures.
- The student must be participating in the debate and solving problem and home works.

### 13. Forms of teaching

PowerPoint slides, white board will be used to explain the lectures  
There will be a simple review and solving problems at end of every chapters

### 14. Assessment scheme

Quizzes , in Class Participations a student activity	10 %
	5%

One exams during one course	25%		
Final Exam	60%		
<b>15. Student learning outcome:</b>			
<ul style="list-style-type: none"> <li>- Students will be able to demonstrate knowledge of principles of geometrical and physical optics, mathematics, optical properties of materials and electromagnetic wave theory. Students will be able to apply these principles to solve technical problems encountered in optics, and possess the necessary skills to develop a solution within a framework of critical thinking</li> <li>-</li> </ul>			
<b>16. Course Reading List and References:</b>			
<ul style="list-style-type: none"> <li>- Key references: Introduction to optics, 3<sup>rd</sup> ed, F.L. Pedrotti, L.S Pedrotti and L.M. Pedrotti(2007). you should have a copy of it.</li> <li>- Biomedical Photonics HANDBOOK , Tuan Vo-Dinh</li> <li>- ENDOSCOPY HANDBOOK 2011 EDITION Edited by Michael Bourke and Ian Norton</li> </ul>			
REFERENCES BOOKS:			
<ul style="list-style-type: none"> <li>- OPTICS, E.Hecht 5<sup>nd</sup> ed.,</li> <li>- Introduction to Modern Optics, G.R Fowels (ISBN 0-486-65957-7).</li> <li>- Optics by Ajoy Ghatak. ( ISBN 978-0-07-338048-3)</li> </ul>			
<b>17. The Topics:</b>			
Chapter	Week	Object	Sections
1, 2	1, 2	Medical Optics : An Introduction Physical meaning of Optics ,Photonic and Medical Optics Nature of light , Geometrical optics	A brief history particles & Medical Optics ,photons,the electromagnetic spectrum ,Huygens and Fermat's principle ,reflection in plan mirror, refraction through plane surface imaging by an Optical system, reflection and refraction from spherical surface, thin lenses, vengeance and refractive power, Newtonian equation and cylindrical lenses.
3	3,4	1-Medical Optics : Ray optics Mirror ,lenses and contact lenses	Stops pupils, and windows, aberration, prism , the camera, simple magnifiers and eyepices. Microscopes.
19	5	Optics of the eyes	Structure of the eye, optical representation of the eye function of the eye, vision correction with external lenses, and surgical vision correction
4,5,7	6,7,8	Introduction to wave equation, superposition and Interference of light	A brief introduction to wave equation , superposition principle, tow beam inference, Young's double- slit experiment interference with virtual sources and

			dielectric films , Newton's rings , film thickness measurement by interference and stokes relations.
8	9	Optical Interferometer	Michelson Interferometer, Fabry-Perot interferometer
11	10,11	Fraunhofer Diffraction	diffraction from a single slit, beam spreading, rectangular and circular apertures, resolution, double slit diffraction , diffraction from many slits,
12	12	The Diffraction grating	The grating equation, dispersion and resolution of grating , types of grating , Grating Instruments
14	13	Production of polarizer light	methods to produce Polarized Light :Dichroic Materials , Polarization by Scattering ,Polarization by Reflection from Dielectric Surfaces , Birefringent Materials ,Double Refraction, optical activity
1,2	14,15	Optical properties of tissue interaction and optics in medicine	Light interact with tissues and some medical instruments such as endoscopy
10	16	Fiber optics	Introduction and applications, optics of propagation

### 18. Practical Topics (If there is any)

### 19. Examinations:

Q1 A / choose the correct answer (12 Marks)

1- A ray in air is incident on a glass plate whose index of refraction is 1.58. The angle of refraction is one-half the angle of reflection. The angle of refraction is closest to

- a)  $34^\circ$                       b)  $38^\circ$                       c)  $30^\circ$                       d)  $36^\circ$

2- What is the approximate magnification of a compound microscope with objective and eyepiece focal lengths of 0.3 cm and 3.6 cm, respectively, and a separation between lenses of 20 cm?

- a) 12                              b) 20                              c) 67                              d) 460

3- The index of refraction benzene is 1.8 the critical angle for total internal reflection , at a benzene-air interface is about

- a)  $56^\circ$                       b)  $47^\circ$                       c)  $34^\circ$                       d)  $22^\circ$

4- A 3.0 cm tall object is placed along the principal axis of a thin convex lens of 30.0 cm focal length. If the object distance is 40.0 cm, which of the following best describes the image distance and height, respectively?

- a) 17.3 cm and 7.0 cm      b) 120 cm and 9.0 cm      c) 17.3 cm and 1.3 cm      d) 120 cm and 1.0 cm

5- A beam of light (frequency =  $5.0 \times 10^{14}$  Hz) enters a piece of glass ( $n = 1.5$ ). What is the frequency of the light while it is in the glass?

- a)  $5.0 \times 10^{14}$  Hz      b)  $7.5 \times 10^{14}$  Hz      c)  $3.3 \times 10^{14}$  Hz      d)  $1.0 \times 10^{14}$  Hz

6- The dispersive power of flint glass is the refractive index of flint glass for red, yellow and violet light are 1.613, 1.620, 1.632 respectively the dispersive power of flint glass is

- a) 0.0117                      b) 0.0074                      c) 0.0195                      d) 0.0306

Q1 B/ fill in the blank (10 marks)

- 1- ----- is the real aperture that limits the angular field of view formed by an optical system
- 2- Prism which consists of two right-angle prism called -----
- 3- -----describes the curvature of the wave front and it is measured in units -----
- 4- Non-ideal images are formed in practice because of-----.
- 5- Light exhibits----- behaviour when exchanging energy with matter, as in the ----- and -----.

Q2 A/ Show that Chromatic Resolving Power of prism is  $R = b \frac{dn}{d\lambda}$  (12 Marks)

Q2 B/ An object 4 cm high is placed at right angles to the axis of a concave mirror and at a distance of 30 cm from the mirror. If the focal length of the mirror is 10 cm find the position, size and nature of the image. By ray tracing (14 Marks)

Q2C/ light incident on an equilateral glass prism at a  $45^\circ$  angle to on face , calculate the angle at which light emerge from the opposite face ( $n=1.58$ ) (12 Marks)

Q3A/ Two identical, thin, Plano-convex lenses with radii of curvature of 15 cm are situated with their curved surfaces in contact at their centres. The intervening space is filled with oil of refractive index 1.65. The index of the glass is 1.50. Determine the focal length of the combination. (15 Marks)

Q3 B/ An equilateral prism of dense barium crown glass are used in a spectroscope. Its refractive index varies with wavelength, as given in the table below: (25 Marks)

$\lambda(\text{nm})$	n	
656.3	1.63461	C- red
587.6	1.63810	D- yellow
486.1	1.64611	F –blue

- a) Determine the minimum angle of deviation for sodium light of 589.3nm
- b) Determine the dispersive power of the prism
- c) Determine the Cauchy constants A and B in the long wavelength region (656.3nm) and find the dispersion of the prism at 656.3nm.
- d) Determine the chromatic resolving power of the prism.

## 20. Extra notes:

1) This course is suitable for the 3<sup>rd</sup> year students (B.Sc.), it's very difficult for the 1<sup>st</sup> and 2<sup>nd</sup> years B.Sc.

2) This course is useful in different fields to get works in private sector.

## 21. Preview

### پیداچونہوہی ھاوہل

This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.

*(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).*

نہم کورسبووکه دهییت له لایهن ھاوہلیکی نهکادیمیوه سهیر بکریت و ناوهرۆکی بابهتهکانی کورسهکه پهسهند بکات و جهند وشهیهک بنوسنیت لهسه شیاوی ناوهرۆکی کورسهکه و واژووی لهسه بکات. ھاوہل نهو کهسهیه که زانیاری ههیییت لهسه کورسهکه و دهییت پلهی زانستی له ماموستا کهمتر نهیییت.