GEOMETRICAL OPTICS

INTRODUCTION :

Blue lakes, ochre deserts, green forest, and multicolored rainbows can be enjoyed by anyone who has eyes with which to see them. But by studying the branch of physics called **optics**, which deals with the behaviour of light and other electromagnetic waves, we can reach a deeper appreciation of the visible world. A knowledge of the properties of light allows us to understand the blue color of the sky and the design of optical devices such as telescopes, microscopes, cameras, eyeglasses, and the human eyes. The same basic principles of optics also lie at the heart of modern developments such as the laser, optical fibers, holograms, optical computers, and new techniques in medical imaging.

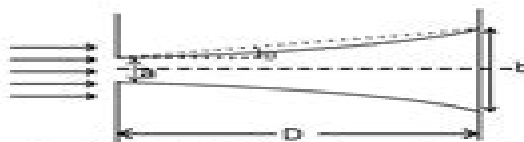## 1.   CONDITION FOR RECTILINEAR PROPAGATION OF LIGHT
(Only for information not in IIT-JEE syllabus)

Some part of the optics can be understood if we assume that light travels in a straight line and it bends abruptly when it suffers reflection or refraction.

The assumption that the light travels in a straight line is correct if

(i) the medium is isotropic, i.e. its behaviour is same in all directions and (ii) the obstacle past which the light moves or the opening through which the light moves is not very small.

Consider a slit of width 'a' through which monochromatic light rays pass and strike a screen, placed at a distance D as shown.

It is found that the light strikes in a band of width 'b' more than 'a'. This bending is called **diffraction**. Light bends by (b–a)/2 on each side of the central line .It can be shown by wave theory of light that

$\sin\theta = \dfrac{\lambda}{a}$ ....(A),   where θ is shown in figure.

This formula indicates that the **bending is considerable only when a $\simeq$ λ** . Diffraction is more pronounced in sound because its wavelength is much more than that of light and it is of the order of the size of obstacles or apertures. Formula (A) gives $\dfrac{b-a}{2D} \approx \dfrac{\lambda}{a}$.

It is clear that the bending is negligible if $\dfrac{D\lambda}{a} << a$ or $a >> \sqrt{D\lambda}$. If this condition is fulfilled, light is said

to move rectilinearly. In most of the situations including geometrical optics the conditions are such that we can safely assume that light moves in straight line and bends only when it gets reflected or refracted.

Thus geometrical optics is an approximate treatment in which the light waves can be represented by straight lines which are called rays. A **ray** of light is the straight line path of transfer of light energy. Arrow represents the direction of propagation of light.

Figure shows a ray which indicates light is moving from A to B.

A ———————▶——————— B
           ray

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Optics: Problems And Solutions Antonio Siciliano,2006-04-25 Optics has been a subject of fascinating investigation in the last three centuries by a large number of eminent scientists With the advent of modern technologies Personal Computers Internet and specialized software like MATLAB new methods and tools for the solution of problems encountered in Optics are now available Written with the student of Physics and Engineering in mind this textbook shows how to solve the typical examination questions In addition the author has included the solutions of many real and difficult problems encountered by the practicing Physicists and Engineers The book is liberally and beautifully illustrated with diagrams from the MATHLAB software Readers can refer to MATLAB scripts using a complementary virtual booklet www optics as com that will also include corrections to unavoidable errors present in this book supplementary problems and readers suggestions

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Theory and Problems of Optics Eugene Hecht,1975   *Mathematical Optics* Vasudevan Lakshminarayanan,María L. Calvo,Tatiana Alieva,2018-10-08 Going beyond standard introductory texts Mathematical Optics Classical Quantum and Computational Methods brings together many new mathematical techniques from optical science and engineering research Profusely illustrated the book makes the material accessible to students and newcomers to the field Divided into six parts the text presents state of the art mathematical methods and applications in classical optics quantum optics and image processing Part I describes the use of phase space concepts to characterize optical beams and the application of dynamic programming in optical waveguides Part II explores solutions to paraxial linear and nonlinear wave equations Part III discusses cutting edge areas in transformation optics such as invisibility cloaks and computational plasmonics Part IV uses Lorentz groups dihedral group symmetry Lie algebras and Liouville space to analyze problems in polarization ray optics visual optics and quantum optics Part V examines the role of coherence functions in modern laser physics and explains how to apply quantum memory channel models in quantum computers Part VI introduces super resolution imaging and differential geometric methods in image processing As numerical symbolic computation is an important tool for solving numerous real life problems

in optical science many chapters include Mathematica code in their appendices The software codes and notebooks as well as color versions of the book s figures are available at www crcpress com **Optics for Engineers** Charles A. DiMarzio,2011-08-09 The field of optics has become central to major developments in medical imaging remote sensing communication micro and nanofabrication and consumer technology among other areas Applications of optics are now found in products such as laser printers bar code scanners and even mobile phones There is a growing need for engineers to understan **The Monte Carlo Methods in Atmospheric Optics** G.I. Marchuk,G.A. Mikhailov,M.A. Nazareliev,R.A. Darbinjan,B.A. Kargin,B.S. Elepov,2013-04-17 This monograph is devoted to urgent questions of the theory and applications of the Monte Carlo method for solving problems of atmospheric optics and hydrooptics The importance of these problems has grown because of the increas ing need to interpret optical observations and to estimate radiative balance precisely for weather forecasting Inhomogeneity and sphericity of the atmos phere absorption in atmospheric layers multiple scattering and polarization of light all create difficulties in solving these problems by traditional methods of computational mathematics Particular difficulty arises when one must solve nonstationary problems of the theory of transfer of narrow beams that are connected with the estimation of spatial location and time characteristics of the radiation field The most universal method for solving those problems is the Monte Carlo method which is a numerical simulation of the radiative transfer process This process can be regarded as a Markov chain of photon collisions in a medium which result in scattering or absorption The Monte Carlo tech nique consists in computational simulation of that chain and in constructing statistical estimates of the desired functionals The authors of this book have contributed to the development of mathemati cal methods of simulation and to the interpretation of optical observations A series of general method using Monte Carlo techniques has been developed The present book includes theories and algorithms of simulation Numerical results corroborate the possibilities and give an impressive prospect of the applications of Monte Carlo methods **Optical Supercomputing** Shlomi Dolev,Mihai Oltean,2009-11-05 This book constitutes the refereed proceedings of the The Second International Workshop on Optical SuperComputing OSC 2009 held in Bertinoro Italy in November 2009 The 18 revised full papers presented together with 1 invited lecture were carefully reviewed and selected from numerous submissions for inclusion in the book Being an annual forum for research presentations on all facets of optical computing for solving hard computation tasks OCS addresses the following topics of interest designs of optical computing devices algorithmics and complexity issues of optical computing computation representation by photons and holograms neural and brain inspired architectures electro optic devices practical implementations analysis of existing devices and case studies optical photonics and laser switching technologies optical and photonic memories optical signal processing subsystems optical networks for high performance computing optical interconnections quantum optical systems applications and algorithms for optical devices Alpha particles X rays and nano technologies for optical computing **Problem Solving** Zygmunt Pizlo,2022-07-07 Intelligent mental representations of

physical cognitive and social environments allow humans to navigate enormous search spaces whose sizes vastly exceed the number of neurons in the human brain This allows us to solve a wide range of problems such as the Traveling Salesperson Problem insight problems as well as mathematics and physics problems As an area of research problem solving has steadily grown over time Researchers in Artificial Intelligence have been formulating theories of problem solving for the last 70 years Psychologists on the other hand have focused their efforts on documenting the observed behavior of subjects solving problems This book represents the first effort to merge the behavioral results of human subjects with formal models of the causative cognitive mechanisms The first coursebook to deal exclusively with the topic it provides a main text for elective courses and a supplementary text for courses such as cognitive psychology and neuroscience   *Optical Physics* Ariel Lipson,Stephen G. Lipson,Henry Lipson,2010-10-28 This fourth edition of a well established textbook takes students from fundamental ideas to the most modern developments in optics Illustrated with 400 figures it contains numerous practical examples many from student laboratory experiments and lecture demonstrations Aimed at undergraduate and advanced courses on modern optics it is ideal for scientists and engineers The book covers the principles of geometrical and physical optics leading into quantum optics using mainly Fourier transforms and linear algebra Chapters are supplemented with advanced topics and up to date applications exposing readers to key research themes including negative refractive index surface plasmon resonance phase retrieval in crystal diffraction and the Hubble telescope photonic crystals super resolved imaging in biology electromagnetically induced transparency slow light and superluminal propagation entangled photons and solar energy collectors Solutions to the problems simulation programs key figures and further discussions of several topics are available at www cambridge org lipson   **Optics for the New Millennium** Kamran M. Riaz,G. Vike Vicente,Daniel Wee,2022-08-25 This textbook serves as a comprehensive manual on Optics that includes both didactics and assessment questions in an easy to read format It provides an educational and entertaining resource that reinforces the relevance of the subject matter to modern clinical and surgical ophthalmology practice The book offers a one stop compendium for students studying for certification exams and for practicing ophthalmologists to review and learn Optics that will have relevance to their day to day practice Chapters are written in a teaching oriented style and include hi yield summaries 375 original figures and 190 review questions The book is divided into three areas of focus Written Exam Preparation Oral Exam Preparation and Clinical Practice Ophthalmic Optics for Surgical Practice Optics for the New Millennium is a must have resource for ophthalmology residents as well as practicing ophthalmologists with clinical surgical and testable relevance   *The Nystrom Method in Electromagnetics* Mei Song Tong,Weng Cho Chew,2020-08-10 A comprehensive step by step reference to the Nystr m Method for solving Electromagnetic problems using integral equations Computational electromagnetics studies the numerical methods or techniques that solve electromagnetic problems by computer programming Currently there are mainly three numerical methods for electromagnetic problems the finite difference time domain FDTD finite element method FEM

and integral equation methods IEMs In the IEMs the method of moments MoM is the most widely used method but much attention is being paid to the Nystr m method as another IEM because it possesses some unique merits which the MoM lacks This book focuses on that method providing information on everything that students and professionals working in the field need to know Written by the top researchers in electromagnetics this complete reference book is a consolidation of advances made in the use of the Nystr m method for solving electromagnetic integral equations It begins by introducing the fundamentals of the electromagnetic theory and computational electromagnetics before proceeding to illustrate the advantages unique to the Nystr m method through rigorous worked out examples and equations Key topics include quadrature rules singularity treatment techniques applications to conducting and penetrable media multiphysics electromagnetic problems time domain integral equations inverse scattering problems and incorporation with multilevel fast multiple algorithm Systematically introduces the fundamental principles equations and advantages of the Nystr m method for solving electromagnetic problems Features the unique benefits of using the Nystr m method through numerical comparisons with other numerical and analytical methods Covers a broad range of application examples that will point the way for future research The Nystrom Method in Electromagnetics is ideal for graduate students senior undergraduates and researchers studying engineering electromagnetics computational methods and applied mathematics Practicing engineers and other industry professionals working in engineering electromagnetics and engineering mathematics will also find it to be incredibly helpful   Landmark Papers On Photorefractive Nonlinear Optics Pochi Yeh,Claire Gu,1995-07-14 This book intended for students researchers and engineers is a collection of classic papers on photorefractive nonlinear optics Included are landmark papers on fundamental photorefractive phenomena two wave mixing four wave mixing phase conjugators and resonators material growth and physics and applications in image processing optical storage and optical computing

Modern Classical Optics Geoffrey Brooker,2003-08-07 The book describes classical non quantum optical phenomena and the instruments and technology based on them It includes many cutting edge areas of modern physics and its applications which are not covered in many larger and more expensive books   Catalog of Copyright Entries. Third Series Library of Congress. Copyright Office,1977   **Optical Waveguide Sciences** H. Huang-Chia,A.W. Snyder,2012-12-06 Over the past decade or more the art relating to modern optical waveguides has evolved as a nighly focused interdis ciplinary field so attractive stimulating and full of far reachin3 promise that no parallel could be found earlier in other branches of applied sciences except perhaps in solid state electronics and computer technology This Proceedings with a selection of 53 papers and briefs by 96 authors of 16 countries is of real internation al dimensions It is the outgrowth of the International Symposium held June 20 23 1983 the first international meeting on this subject taking place in China Since almost every country in the world Eastern or estern large or small has been involved in the study and promotion of this technological revolution it is only natural that China snoula be happy to serve as host country of the international meeting to promote an

interchange of experiences and iaeas conducive to greater achievements in the future   **Laser Induced Damage in Optical Materials:1978** ,   Optical Networks and Components Partha Pratim Sahu,2022-07-30 Intended as an undergraduate post graduate level textbook for courses on high speed optical networks as well as computer networks Nine chapters cover basic principles of the technology and different devices for optical networks as well as processing of integrated waveguide devices of optical networks using different technologies It provides students researchers and practicing engineers with an expert guide to the fundamental concepts issues and state of the art developments in optical networks Includes examples throughout all the chapters of the book to aid understanding of basic problems and solutions

Electronics Fundamentals and Applications D. Chattopadhyay,P. C. Rakshit,2008   **Diffractive Optics** Donald C. O'Shea,2004 This book provides the reader with the broad range of materials that were discussed in a series of short courses presented at Georgia Tech on the design fabrication and testing of diffractive optical elements DOEs Although there are not long derivations or detailed methods for specific engineering calculations the reader should be familiar and comfortable with basic computational techniques This text is not a cookbook for producing DOEs but it should provide readers with sufficient information to assess whether this technology would benefit their work and to understand the requirements for using the concepts and techniques presented by the authors

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