Nanyang Technological University
Division of Physics and Applied Physics

Academic Year	2018/19	**Semester**	2
Course Coordinator	Assoc. Prof. David Wilkowski and Asst. Prof. Ranjan Singh		
Course Code	PH2301		
Course Title	Physical Optics		
Pre-requisites	PH1105		
No of AUs	3 AU		
Contact Hours	PH2301 (2 hr – lecture; 1 hr – tutorial)		
Proposal Date	01/2019		

Course Aims

This course aims to equip you with the basic concepts and problem solving skills in physical optics and electromagnetic wave phenomena. You will develop physical intuition and analytical skills which are important for studying the detailed nature and propagation of light wave, its polarization, interference and diffraction properties. You will solve problems based on electromagnetic theory of light, superposition of light waves, polarization, interference and diffraction. These knowledge and skills lay the foundation for subsequent higher level courses in photonics and applied physics which would also be very useful in the engineering and design profession.

Intended Learning Outcomes (ILO)

Upon the successful completion of this course, you (as a student) would be able to:

Wave motion and electromagnetic theory of light (WET)

1. solve problems for 1-D waves (such as phase velocity, group velocity, complex representations of waves).
2. draw phasor diagrams for superposition and addition of waves.
3. analyse light in vacuum and bulk matter using electromagnetic theory.

Propagation of Light (PROP)

4. analyze and solve problems on reflection, refraction, and total internal reflection
5. solve problems using Stoke's treatment of reflection and refraction

Geometrical Optics (GO)

6. explain the functionalities and mechanism of optical systems (such as lenses, prisms and wavefront shaping).
7. analyze ray tracing of different optical systems involving lenses and mirrors and solve problems on geometrical optics.

Superposition of waves, Interference and diffraction (SWID)

8. analyze and solve problems on addition of waves of same and different frequency.
9. apply the principle of superposition to derive the conditions for interference and solve problems involving interference (such as single and multilayer films).
10. analyze and solve problems using conditions for Fraunhofer and Fresnel diffraction

Polarization (POL)

11. explain the phenomenon of polarization (such as nature of polarized light and existence of different polarization states) and the mechanism of optical devices (such as birefringence, phase retarders and optical activity).
12. analyze and solve problems on polarization (such as Brewster's angle and polarization by reflection).

Course Content

Wave motion and electromagnetic theory of light (WET)
One-dimensional waves
Phase and group velocities
Superposition principle
Phasors and additional of waves
Three-dimensional differential equation
Electromagnetic waves
Light in bulk matter

Propagation of Light (PROP)
Rayleigh Scattering
Reflection
Refraction
Total Internal Reflection
Optical properties of metals

Geometrical Optics (GO)
Lenses
Mirrors
Prisms
Optical Systems
Thick lenses and lens systems
Analytical Ray tracing

Superposition of waves, interference and diffraction (SWID)
Addition of waves
Periodic Waves
Conditions for Interference
Interference fringes
Applications of Single and Multilayer Films
Fraunhofer Diffraction
Fresnel Diffraction

Polarization (POL)
Nature of Polarized light
Polarizers
Birefringence
Brewster's angle
Polarization by reflection
Retarders and circular polarizers
Optical Activity
Mathematical description of Polarization

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team / Individual	Assessment Rubrics
1. Final Examination	All	Competency (1,3,4), Communication (1)	60%	Individual	Point-based marking (not rubric-based)
2. CA1: Online Assessment	All	Competency (1,3,4)	10%	Individual	Point based marking (not Rubrics based)
3. CA2: Homework	All	Competency (1,3,4)	10%	Individual	Point-based marking (not rubric-based)
4. CA3: Mid-term 1	**WET** 1-3 **PROP** 4-5 **GO** 6-7	Competency (1,3,4)	10%	Individual	Point-based marking (not rubric-based)
5. CA4: Mid-term 2	**SWID** 8-10 **POL** 11	Competency (1,3,4)	10%	Individual	Point-based marking (not rubric-based)
Total			100%		

Formative feedback

Formative feedback is given through discussion within tutorial lessons

Formative feedback is given via the student response application Learning Catalytics where you are required to answer on your mobile devices questions posted during lecture/tutorial. Feedback is always provided for your response to each question.

Feedback is also given after each midterm on the common mistakes and level of difficulty of the problems. Past exam questions are made available for you.

Learning and Teaching approach

Approach	How does this approach support you in achieving the learning outcomes?
Use of Learning Catalytics (tutorial and lecture)	You are able to see how well your peers answer questions and thus understand your relative progress in comprehension.
Lectures	Warm-up questions will be raised first, followed by lectures that further explain the physics based on the questions. Then wrap-up questions will also be provided.
Tutorial	You will review main concepts learned in lectures with TAs. This helps you to digest and understand better.
Homework	The homework comprises standard textbook practice questions that are covered during tutorial.

Reading and References

1. Optics, 5th Edition by Eugene Hecht, Pearson Education. ISBN-13: 9780133979121

Course Policies and Student Responsibilities

Absence Due to Medical or Other Reasons

If you are sick and unable to attend your class / Mid-terms, you have to:

1. Send an email to the instructor regarding the absence and request for a replacement class and make-up mid-terms.
2. Submit the original Medical Certificate* or official letter of excuse to administrator.
3. Attend the assigned replacement class (*subject to availability*) and make-up mid-terms.

* The medical certificate mentioned above should be issued in Singapore by a medical practitioner registered with the Singapore Medical Association.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Asst. Prof. Ranjan Singh	SPMS-PAP-03-13	63162965	ranjans@ntu.edu.sg
Assoc. Prof. David Wilkowski	SPMS-PAP-03-15	65137407	david.wilkowski @ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Wave motion and Electromagnetic Theory	**WET** 1-3	Pre-lecture videos, Lecture Notes, Optics by Hecht, Chapter 2,3
2	Propagation of Light	**PROP** 4-5	Pre-lecture videos, Lecture Notes, Optics by Hect, Chapter 4
3	Geometric Optics	**GO** 6	Pre-lecture Video, Lecture notes, Chapter 5 by Hecht
4	Geometric Optics	**GO** 7	Pre-lecture videos, Lecture notes, Chapter 6 by Hecht
5	Superposition of waves	**SWID** 8	Mid-Term 1
6	Interference	**SWID** 9	Pre-lecture videos, lecture notes, Chapter 7, and 9 by Hecht
7	Interference	**SWID** 9	Pre-lecture videos, lecture notes, chapter 9 by Hecht
8	Diffraction	**SWID** 10	Pre-lecture videos, lecture notes, chapter 10 by Hecht
9	Polarization	**POL** 11	Pre-lecture videos, lecture notes, chapter 8 by Hecht
10	Polarization	**POL** 11	Mid-Term 2
11	Polarization	**POL** 12	Pre-lecture videos, lecture notes, chapter 8 by Hecht
12	Polarization	**POL** 12	Lecture notes, chapter 8 by Hecht
13	Revision	All	Lecture notes

Graduate Attributes

What we want our graduates from Physics and Applied Physics to be able to do:

Upon the successful completion of the PHY, APHY and PHMA programs, graduates should be able to:

Competency	1	demonstrate a rigorous understanding of the core theories and principles of physics involving (but not limited to) areas such as classical mechanics, electromagnetism, thermal physics and quantum mechanics [PHMA only] demonstrate a rigorous understanding of the core theories and principles of mathematical sciences involving (but not limited to) areas such as analysis, algebra and statistical analysis
	2	read and understand undergraduate level physics content independently;
	3	make educated guesses / estimations of physical quantities in general;
	4	apply fundamental physics knowledge, logical reasoning, mathematical and computational skills to analyse, model and solve problems;
	5	develop theoretical descriptions of physical phenomena with an understanding of the underlying assumptions and limitations;
	6	critically evaluate and distinguish sources of scientific/non-scientific information and to recommend appropriate decisions and choices when needed;
	7	demonstrate the ability to design and conduct experiments in a Physics laboratory, to make measurements, analyse and interpret data to draw valid conclusions.

Creativity	1	propose valid approaches to tackle open-ended problems in unexplored domains;
	2	offer valid alternative perspectives/approaches to a given situation or problem.

Communication	1	describe physical phenomena with scientifically sound principles;
	2	communicate (in writing and speaking) scientific and non-scientific ideas effectively to professional scientists and to the general public;
	3	communicate effectively with team members when working in a group.

Character	1	uphold absolute integrity when conducting scientific experiments, reporting and using the scientific results;
	2	readily pick up new skills, particularly technology related ones, to tackle new problems;
	3	contribute as a valued team member when working in a group.

Civic Mindedness	1	put together the skills and knowledge into their work in an effective, responsible and ethical manner for the benefits of society.