Nanyang Technological University
Division of Physics and Applied Physics

Academic Year	2020/21	**Semester**	1
Course Coordinator	Assoc. Prof. Zhang Baile		
Course Code	PH1105 / PH115S[1]		
Course Title	Optics, Vibrations and Waves		
Pre-requisites	Physics and Maths at A or H2 level, or equivalents		
No of AUs	3 AU		
Contact Hours	PH1105 (2 hr – lecture; 1 hr – tutorial)		
Proposal Date	3 March 2020		

Course Aims

This course aims to equip you with basic concepts and problem solving skills in optics and wave phenomena. You will develop physical intuition and basic analytical skills which are important for studying optical rays and wave propagation. Fundamental concepts are emphasized using the framework of phase and wavefronts. These knowledge and skills lay the foundation for subsequent higher level courses in optics, and are also critical in any other wave-related courses such as quantum mechanics and electrodynamics.

Intended Learning Outcomes (ILO)

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

Vibrations (V)

1. describe vibrations in terms of physical quantities (such as amplitude, period, frequency and angular frequency) and analyse vibration problems using the model of simple harmonic motion.

Mechanical Waves (MW)

2. determine the mathematical expression of a sinusoidal periodic wave using wave quantities (such as speed, frequency and wavelength) and visualize the wave function along a 1D spatial axis.
3. determine various physical quantities of a particle (such as velocity and acceleration) in a sinusoidal wave and analyse the speed of a sinusoidal wave.
4. explain wave interference and boundary conditions in 1D, and the phenomenon of standing waves.

Sound and Hearing (SH)

5. describe a sound wave in terms of particle displacements and pressure fluctuations.
6. determine various physical quantities (such as resonant frequency) of the sound produced by musical instruments (such as organ and flute).
7. analyse the phenomenon involving sound waves (such as interference of sound wave and Doppler effect).

Nature and Propagation of Light (NPL)

8. explain the relationship between light rays, wave fronts and phase.
9. apply theoretical concepts (such as law of reflection and refraction) to solve problems involving visible light and explain the phenomenon of visible light (such as formation of rainbow and polarization).

Geometric Optics (GO)

10. analyse and calculate the image formed by plane, concave and convex mirrors.
11. explain how images can be formed by a curved interface between two transparent materials.
12. determine the image formed by a thin lens and multiple lenses.

[1] PH115S is a self-paced version of the course.

Interference (I)

13. describe the interference phenomenon in 2D and analyse the thin film interference.
14. determine various physical quantities (such as intensity) in an interference pattern from two point sources.

Diffraction (D)

15. explain the diffraction phenomenon when coherent light shines on an object through an aperture or an edge.
16. determine various physical quantities (such as intensity) in a single-slit diffraction pattern
17. explain the significance of diffraction limit in an optical system.

Course Content

Vibration (V)
Amplitude, period, frequency, and angular frequency
Simple harmonic motion
Displacement, velocity, and acceleration in simple harmonic motion

Mechanical Waves (MW)
Transverse wave and longitudinal wave
Sinusoidal wave
Speed of a wave
1D wave interference
Standing wave

Sound and Hearing (SH)
Audible frequency range
Pressure fluctuations
Speed of sound
Resonance
2D wave interference
Doppler effect

Nature and Propagation of Light (NPL)
Light rays, wave fronts, phase
Laws of reflection and refraction
Dispersion
Polarization

Geometric Optics (GO)
Light rays, wave fronts, phase
Laws of reflection and refraction
Dispersion
Polarization

Interference (I)
Two-slit interference
Interference in thin films

Diffraction (D)
Single-slit diffraction

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)	60%	Individual	Point-based marking (not rubric-based)
2. CA1: Weekly online assessment	All	Competency (1,3,4)	10%	Individual	Point based marking (not Rubrics based)
3. CA2: Weekly homework	All	Competence (1,3,4), Character (1,2), Communication (1)	10%	Individual	Point-based marking (not rubric-based)
4. CA3: Mid-term 1	V 1-2 MW 3-6 SH 7-10 NPL 11-14	Competency (1,3,4)	10%	Individual	Point-based marking (not rubric-based)
5. CA4: Mid-term 2	V 1-2 MW 3-6 SH 7-10 NPL 11-14	Competency (1,3,4)	10%	Individual	Point-based marking (not rubric-based)
Total			100%		

Formative feedback

You will receive formative feedback through discussion within tutorial lessons as well as interactive, computer-based hints and pointers in the Mastering Physics online assignment and resource system.

Formative feedback is also 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.

Finally, feedback is also given after each midterm on the common mistakes and level of difficulty of the problems. Past exam questions and examiner's report are also made available for you.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Problem solving (tutorial and lecture)	Develop competence and perseverance in solving physics problems
Learning Catalytics (tutorial and lecture)	Provide immediate feedback to correct misconceptions
In-class demos and videos	Help to establish physics intuition based on expeirment

Reading and References

1. University Physics with Modern Physics, 14th Edition, H. D. Young and R. A. Freedman, Pearson (2016) ISBN-13: 9780133975987
2. Physics for Scientists & Engineers with Modern Physics, 4th Edition, D. C. Giancoli, Pearson (2008) ISBN 13: 9780131495081
3. College Physics: A Strategic Approach Edition, 3rd Edition, R. D. Knight, B. Jones, S. Field, Pearson (2015) ISBN-13: 9780321879721

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
Assoc. Prof. Zhang Baile	SPMS-PAP-0506	65921653	blzhang@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Vibrations	**V** 1-2	Lecture Notes, In-class Learning Catalytics Mastering Physics on-line assignment, Post-tutorial videos
2	Mechanical Waves	**MW** 3-4	
3	Mechanical Waves	**MW** 5-6	
4	Sound and Hearing	**SH** 7-10	
5	Nature and Propagation of Light	**NPL** 11-14	
6	Geometric Optics	**GO** 15-16	
7	Geometric Optics	**GO** 17	
8	Midterm test		Midterm test
9	Interference	**I** 18	Lecture Notes, In-class Learning Catalytics Mastering Physics on-line assignment, Post-tutorial videos
10	Interference	**I** 19-20	
11	Diffraction	**D** 21-22	
12	Diffraction	**D** 23	
13	Revision	All	All

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.