Course Code	PHYS8852 (RPG)		
Title	Photonics and Metamaterials		
Offering Department	Physics		
Course Co-ordinator	Prof S Zhang Physics		
Course Co-ordinator Email	shuzhang@hku.hk		
Teachers Involved	Name	Department	Percentage
	Prof S Zhang	Physics	100
Course Objectives	In the last two decades, tremendous progress has been made in the manipulation of light propagation using structured photonic media - metamaterials, with negative refraction, super-imaging and invisibility cloaking as the most well-known examples. These new discoveries are paving ways towards many potential applications of photonic structures, including imaging, display, holography, and information processing. This course aims at providing the fundamental understanding of the interaction of light with structured media whose unit cells are much smaller than the wavelength of light, and the design and functionalities of various metamaterial-based photonic devices. The course text is primarily designed for senior undergraduate students and postgraduate students and requires some knowledge on electromagnetism and optics. On the other hand, it will also be of interest to graduate students since it includes some most recent results in the field of metamaterials and nanophotonics.		
Course Contents & Topics	Topics include: Modeling of interaction of light with periodic structures, gratings, photonic crystals; coupled mode theory; interaction of light with metals, covering both propagating and localized surface plasmon polaritons; effective-medium description of the unconventional electromagnetic properties of metamaterials, such as negative permeability and negative refraction, zero refractive index, hyperbolic metamaterial, chirality and bi-anisotropy; design of the unit cells of the metamaterials based on plasmonic structures for achieving various electromagnetic properties and functionalities; transformation optics and invisibility cloaks; metamaterial devices, including super-imaging lenses, meta-lenses, metasurface holography etc.; nonlinear optical properties of metamaterials and metasurfaces; photonic systems with Parity-time symmetry; metamaterial approach for designing the topological properties for light.		
Course Learning Outcomes (CLO)	On successful completion of this course, students should be able to: CLO 1 learn the modeling of interaction of light with periodic structures; CLO 2 understand the interaction of light with plasmonic structures at subwavelength scale; CLO 3 learn the homogenization and retrieval of electromagnetic properties for structured media. CLO 4 learn how to design metamaterials with bespoke electromagnetic properties. CLO 5 understand the operation of various metamaterial based photonic devices. CLO 6 understand the linear and nonlinear interaction of light with metasurfaces. CLO 7 understand the topological properties of metamaterials.		
Pre-requisites (and Co-requisites and Impermissible combinations)	Nil		
Offer in 2023 - 2024	Y 1st sem	Examination	Dec
Course Grade	Pass or Fail		

Grade Descriptors	Pass: Demonstrate thorough mastery at an advanced level of extensive knowledge and skills required for attaining all the course learning outcomes. Show strong analytical and critical abilities and logical thinking, with evidence of original thought, and ability to apply knowledge to a wide range of complex, familiar and unfamiliar situations. Apply highly effective organizational and presentational skills. Fail: Demonstrate little or no evidence of command of knowledge and skills required for attaining the course learning outcomes. Lack of analytical and critical abilities, logical and coherent thinking. Show very little or no ability to apply knowledge to solve problems. Organization and presentational skills are minimally effective or ineffective.		
Course Type	Lecture-based elective course		
Course Teaching & Learning Activities	Activities	Details	No. of Hours
	Lectures		36
	Tutorials		12
	Reading/Self study		80
Assessment Methods and Weighting	Methods	Details	Weighting in final course grade (%)
	Assignments		50
	Examination	2-hour written exam	50
Quota	9999 (9999 if no quota)		
Required/recommended reading and online materials	S. A. Maier, *Plasmonics: Fundamentals and Applications*, Springer, 2007 W Cai and V. M. Shalaev, *Optical Metamaterials*, Springer, 2010		