جامعة الملك عبدالله للعلوم والتقنية
King Abdullah University of Science and Technology

Course Syllabus: Advanced Topics in Wave Propagation - AMCS 353

Division	Computer, Electrical and Mathematical Sciences & Engineering
Course Number	AMCS 353
Course Title	Advanced Topics in Wave Propagation
Academic Semester	Spring
Academic Year	2018/2019
Semester Start Date	01/27/2019
Semester End Date	05/23/2019
Class Schedule (Days & Time)	10:30 AM - 12:00 PM | Mon Wed

Instructor(s)

Name	Email	Phone	Office Location	Office Hours
Ying Wu	Ying.Wu@kaust.edu.sa	+966128080432	4249, 1, Al-Khawarizmi (bldg. 1)	TBA

Teaching Assistant(s)

Name	Email
TBA	

Course Information

Comprehensive Course Description	AMCS 353 (3 credits). This course starts from the basic linearized theory of wave phenomena: examples are chosen from electromagnetics, acoustics, elastics and other subjects, and explores the recent developments in wave propagation. The topics include: basic concepts in wave propagation; waves in layered media; two and three dimensional cases; scattering, transmission and reflection; waves in random media; effective medium properties; resolution analysis; applications in wave functional materials and imaging; and numerical techniques in solving wave equations in heterogeneous media. Knowledge on Fourier transform, eigenvalue problem, Special functions (Bessel/Hankel/Spherical Harmonics), vector analysis is desired. Course Details 1.Introduction: wave equations (Electromagnetic, acoustic and elastic wave equations) and relevant length scales 2. Waves in Homogeneous Media: Solutions to wave equations, and Green's functions 3.Waves in Complex Media: One dimensional layered media: (Scattering by a single interface; Single layer case: Reflection and Transmission; Multilayer cases); Two and three dimensional cases with isotropic scatterers: (Single scatterer; Multiple scatterers) 4.Effective Medium Theory: Introduction to random media and law of large numbers; EMT based on transmission and reflection coefficients (parameter retrieval); EMT based on coherent potential approximation; EMT based on multiple-scattering theory 5.Wave Functional Materials: photonic/phononic crystal; wave guide; metamaterials, super-resolution 6. Numerical Methods and Fast Algorithms
Course Description from Program Guide	This course starts from the basic linearized theory of wave phenomena: examples are chosen from electromagnetics, acoustics, elastics and other subjects, and explores the recent developments in wave propagation. The topics include: basic concepts in wave propagation; waves in layered media; scattering, transmission and reflection; waves in random media; effective medium properties, resolution analysis; applications in wave functional materials and imaging; and numerical techniques in solving wave equations in heterogeneous media. Basic knowledge on eigenvalue problem, Fourier transform, linear algebra, vector analysis is desired.

Goals and Objectives	At the end of the course, the students are expected to 1. Understand the basic concepts about wave propagation; know the difference between quantum and classical waves; familiar with the d'Alembert solution, spherical mean methods 2. Familiar with waves in layered media: master the derivation of transmission and reflection coefficients 3. Understand the concept of homogenization; know the derivations and limitations of different effective medium theories 4. Be aware of the cutting-edge developments on metamaterials, artificial materials
Required Knowledge	The students should have basic knowledge on PDE (method of characteristics, separation of variables, eigenvalue problem); vector analysis; complex analysis; Fourier analysis.
Reference Texts	References: [1] Jean-Pierre Fouque, Josselin Garnier, George Papanicolaou, and Knut Solna; “Wave Propagation and Time Reversal in Randomly Layered Media” Springer 2007 [2] Ping Sheng, “Introduction to Wave Scattering, Localization and Mesoscopic Phenomena” Springer 2006
Method of evaluation	**5.00**% - Attendance **30.00**% - Homework /Assignments **50.00**% - Final exam **15.00**% - Active participation
Nature of the assignments	3-5 written assignements Students will choose the way of the final exam (an oral presentation with a written report or a standard written exam
Course Policies	Late homework won't be graded. Plagiarism is strictly phohibited. Absences should be justified and should comply with the University policy.
Additional Information	

Tentative Course Schedule *(Time, topic/emphasis & resources)*		
Week	**Lectures**	**Topic**
1	Mon 01/28/2019 Wed 01/30/2019	Background test, introduction
2	Mon 02/04/2019 Wed 02/06/2019	Introduction: Wave equations (electromagentic, acoustic)
3	Mon 02/11/2019 Wed 02/13/2019	Introduction: acoustic and elastic wave equations
4	Mon 02/18/2019 Wed 02/20/2019	Introduction: elastic wave equation, relevant lenth scales.
5	Mon 02/25/2019 Wed 02/27/2019	Waves in homogeneous media Solving 1D wave equation. Plane waves, D'Alembert Solution,
6	Mon 03/04/2019 Wed 03/06/2019	3D wave equation and spherical means Green's function
7	Mon 03/11/2019 Wed 03/13/2019	Wave decomposition. propagating and evanscent waves, super resolution
8	Mon 03/18/2019 Wed 03/20/2019	Waves in layered media, interfaces
9	Mon 03/25/2019 Wed 03/27/2019	Spring Break
10	Mon 04/01/2019 Wed 04/03/2019	Waves in layered media, transmission and reflection
11	Mon 04/08/2019 Wed 04/10/2019	waves in layered media, scattering
12	Mon 04/15/2019 Wed 04/17/2019	waves in layered media, scattering matrix, and periodic media
13	Mon 04/22/2019 Wed 04/24/2019	Waves in layered media: effective medium
14	Mon 04/29/2019 Wed 05/01/2019	Waves in 2D and 3D periodic systems, photonic crystals
15	Mon 05/06/2019 Wed 05/08/2019	Mie theory and effective medium
16	Mon 05/13/2019 Wed 05/15/2019	Wave functional materials and miscellaneous
17	Mon 05/20/2019 Wed 05/22/2019	Final Exam Week

Note

The instructor reserves the right to make changes to this syllabus as necessary.