MATH0080 Waves and Wave Scattering

Year:	2024–2025
Code:	MATH0080
Level:	7(UG)/7(PG)
Normal student group(s):	UG Year 3 and 4 Mathematics degrees PG MSc Mathematical Modelling
Value:	15 credits (= 7.5 ECTS credits)
Term:	2
Assessment:	90% examination, 10% coursework
Normal Pre-requisites:	MATH0016
Lecturer:	Prof V Smyshlyaev

Course Description and Objectives

Modelling the propagation and scattering of acoustic and electromagnetic waves has proved a major challenge to mathematicians and physicists for many centuries, and its practical importance can be observed in many applications prevalent throughout our modern world. These include the mitigation of aircraft, rail and traffic noise in urban areas, sonar detection, wireless and fibre optic communication, baggage screening, medical diagnostics and the workings of the cochlea. This course aims to provide an introduction to linear and nonlinear wave theory and the approximate methods used to tackle wave reflection, transmission and scattering in inhomogeneous media.

Recommended Texts

(i) Pierce, A.D, *Acoustics: an introduction to its physical principles and applications,* Acoustic Society of America 1989.

(ii) Billingham, J. and King, A.C. *Wave Motion,* CUP 2001.

Detailed Syllabus

The topics will be chosen from the following:

- Acoustic waves - governing equations, plane acoustic waves, spherically symmetric waves, time-harmonic waves, causality and the Sommerfield radiation condition, acoustic energy and intensity.
- Electromagnetic (EM) waves - governing equations, plane EM waves, Poynting's vector.
- Impedance and surface boundary conditions, interfacial boundary conditions.
- Plane wave reflection and transmission at interfaces - reflection by acoustically soft and hard boundaries and by a perfect conductor, reflection and transmission between two insulators.
- Radiation from vibrating bodies - a radially pulsating sphere, a traversely oscillating sphere.
- Green's functions, monopoles, dipoles, quadrupoles, multipole expansions.
- Kirchoff-Helmholtz integral theorem, acoustic scattering by air bubbles in water.

– Introduction to the WKB approximation, waveguides.