Engineering Tripos Part IIB, 4A15: Aeroacoustics, 2020-21

Module Leader

Dr A Agarwal [1]

Lecturers

Dr A. Agarwal and Dr A. Gregory

Timing and Structure

Lent term: 16 lectures + 2 examples classes; Assessment: 100% exam

Prerequisites

3A1 useful, 3C6 useful

Aims

The aims of the course are to:

- analyse and solve a range of practical engineering problems associated with acoustics.

Objectives

As specific objectives, by the end of the course students should be able to:

- understand what sound is and how we perceive it
- understand how sound is generated and propagated
- understand the acoustics of a wide range of music and noise production

Content

We will analyse and solve a range of practical engineering problems associated with acoustics. Examples include modelling of noise sources from jets, fans, musical instruments, human voice, kettles, dripping taps, whistling mice, singing flames, etc. We will also study ways to reduce noise either at the source or through acoustic damping. Upon completion of this module, the students would be well placed to pursue academic research in the area of acoustics and related fields or to work in industry (the topics covered in the course is of interest to GE, Rolls-Royce, Airbus, Dyson, Mitsubishi Heavy Industries, automotive companies, music industry, and acoustic consultancies).

What is sound and how does it propagate? (5L) (Dr A Gregoryl)

- Introduction
- The wave equation
- Some simple 3D wave fields (plane waves, surface waves and spherical waves)

- Sound transmission through different media

Simples sounds sources (2L) (Dr A Agarwal)

- Pulsating sphere
- Oscillating sphere
- Example: loudspeaker with and without a cabinet

General solution to wave eqn (2L) (Dr. A Gregory)

- Green's function
- Sound from general mass and force sources (examples, Bliz siren and singing telephone wires)

Jet noise (Dr A Agarwal) (1 L)

- Scaling of jet noise. How much does jet noise increase by if we double the jet's velocity?
- What do jets and tuning forks have in common?
- Lighthill's acoustic analogy
- Sound of aircraft jets and handdriers

Duct acoustics (2 L) (Dr A Agarwal)

- Rectangular ducts (example, sound box)
- Low-frequency sound in ducts
- Circular ducts
- Acoustic liners (Helmholtz resonator, blowing over a beer bottle)

Musical acoustics & everyday things (3L) (Drs A Agarwal and A Gregory)

- String instruments
- Wind instruments
- Brass instruments
- Whistling of steam kettles and Rayleigh's Bird Call
- Acoustics of dripping taps

Vocalisation (0.5 L) (Dr A Gregory)

- Human speech, singing and overtone singing
- Mice mating calls

Fan noise (1L) (Dr A Agarwal)

- Rotor alone noise
- Rotor-stator interaction noise

Thermoacoustics instability (0.5 L) (Dr A Agarwal)

- Rijke tube experiment (singing flames)

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [3] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [4] which sets out the standard for degree accreditation.

The Output Standards Matrices [5] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links
[1] mailto:aa406@cam.ac.uk
[2] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[3] http://www.engc.org.uk/ukspec.aspx
[4] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[5] http://teaching.eng.cam.ac.uk/content/output-standards-matrices