P408H Electronic Signals Transmission (PHYS4005)

Course Information Guide 2023-2024

1 Course Details

P408H Electronic Signals Transmission is a level 4 Physics Honours elective course. It is composed of 18 lectures and 2 full class tutorials, all given in Semester 2.

Lecturer: Iain Martin
Room 461, Kelvin Building
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Time and place: Normally Wednesdays and Fridays 11:00 – 12:00
Venue – see Moodle timetable.

Recommended Text: none – see Moodle for further information

Course notes and question sheets will be made available on Moodle.

2 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 H-level credits.

3 Required Knowledge

Students are expected to have completed the core Level 3 courses, in particular P301H Mathematical Methods I. They should be familiar with the Fourier transform and related mathematical concepts and with the fundamentals of circuits, voltages and currents from 1st and 2nd year courses.

4 Intended Learning Outcomes

By the end of the course, students will be able to demonstrate a knowledge and broad understanding of Electronic Signals Transmission. They should be able to describe and analyse quantitatively processes, relationships and techniques relevant to the topics included in the course outline, applying these ideas and techniques to solve general classes of problems which may include straightforward unseen elements. They should be able to write down and, where appropriate, either prove or explain the underlying basis of physical laws relevant to the course topics, discussing their applications and appreciating their relation to the topics of other courses taken.

5 Course Outline

5.1 Part I Analogue signals

Basic concepts :

Information theory, signals, noise, channels, bandwidth, time domain, frequency domain. Briefly: analogue and digital signals. The time and frequency domains; mathematical tools: periodic signals and Fourier series, non-periodic signals and Fourier transforms. Power and energy spectra. The Fast Fourier Transform for digital/numerical calculation of Fourier transforms.

Noise:

Defining noise, representing noise, sources and types of noise – Johnson noise and shot noise, quantifying noise – the signal to noise ratio, noise figure and noise temperature.

Filtering:

Linear systems, filters and their effect on signals.

Signal transmission:

Frequency division multiplexing, modulation and demodulation, bandwidth requirements and case studies – amplitude modulation, frequency modulation.

Modulation and measurement:

Lock-in methods, modulation to negate 1/f noise, chopping; applications in physics.

5.2 Part II. Digital aspects

Digitisation of signals:

ADC, DAC, sample and hold, multiplexing etc; Dynamic range and number of bits to digitise a message; sampling theorem, its derivation and its physical basis, aliasing of signals etc.

Information:

Information content of a message, Hartley-Shannon theorem; information capacity of a channel, bandwidth issues for analogue and digital transmission of the same basic signal, maximum capacity of a channel in the presence of white noise, digitisation noise and signal-to-noise ratio in a system limited by such noise.

Errors:

How they arise, their rectification; multiple messages, parity bits etc. CD player as an information channel Digitisation rate, dynamic range, channel capacity and information coding; oversampling etc.

Data compression and data thinning:

Application to audio: MP3, data masking; Huffman Coding; applications.