Module Name: Antennas and Propagation

Module Acronym: A & P

Module Manager: Professor Paul Brennan

Course Summary
The antennas and propagation module aims to give a good grounding in a range of antenna and array designs, methods used for their measurement and the principles of radiowave propagation. The material is developed from fundamental principles and illustrated with numerous practical examples of working antenna and array systems.

Intended Learning Outcomes
On completion of this course, students should be able to:

- Understand the basic definitions of antennas and antenna systems, including gain, directivity, polarization, array factor and so on.
- Make basic calculations of propagation loss, taking into account free-space loss and polarization effects, and extend this to a link budget analysis.
- Analyse, from first principles, the basic properties of a range of antennas, such as dipoles, parabolic reflector antennas, horn antennas, printed patch antennas.
- Appreciate the trade-offs between antenna properties, such as aperture efficiency and sidelobe levels and be able to demonstrate these using fundamental principles.
- Apply numerical modeling tools such as CST (by means of the lab experiment) to design antennas, with particular reference to a printed patch antenna.
- Design antennas and antenna systems to fulfill particular practical requirements, an example being a stack of dipoles for a broadcast antenna.
- Perform antenna measurements using facilities such as far-field antenna ranges (to measure radiation pattern and/or gain) and network analysers (to measure impedance bandwidth).
- Understand the limitations of antennas and antenna systems, both fundamental and practical, and how best to arrive at an economic and environmentally-friendly solution.
Course Content

- Basic antenna definitions: Gain, directivity, efficiency, effective area and length, directional patterns and polarization.

- Propagation principles: Friis transmission formula, atmospheric effects, fading, tropospheric scatter, link budget calculation.

- Hertzian dipole reactive and far field patterns.

- Types of radiating element.

- Antenna theory, covering: Fourier transforms in antennas, displacement theorem, amplitude tapers and sidelobe levels, orthogonality, pattern synthesis, near and far field patterns and focused apertures.

- Arrays and electronic beam control: Interferometers, linear arrays, the product theorem, frequency-scanned arrays, phase and time delay compensation, null steering, switched-line phase shifter and sidelobe levels, vector modulators and multiple beamforming arrays.

- Digital beamforming: smart antenna systems in mobile applications Reflector and lens antennas: including the feed systems.

- Antenna measurements and anechoic chambers.

- Horn antennas, printed and helical antennas and slot antennas.

- Printed patch antenna laboratory.
**Assessment:**
A 2 and half hour unseen written examination will be held under UCL MSc examination regulations at UCL.

**Tutorials/Workshops:**
An afternoon tutorial is offered, usually the week following the module delivery. A one-day antenna design laboratory is held during the week of the module delivery.