

Faculty of Engineering and Physical Sciences

A Continuing Education Course on

Antennas and Propagation

30 October – 3 November 2017

Enquiries to:

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Overview

The course is designed to provide an overview of the fundamental principles associated with microwave and RF antennas and propagation. The course will present the underlying theory in an accessible manner, together with techniques for application of the theory to satellite and mobile communications scenarios as well as broadcasting and indoor wireless applications. The course is partly based on a MSc modules taught at Surrey University. Topics include antenna principles and calculations from electromagnetic theory; radio propagation modelling, overcoming channel impairments, antenna design with the inclusion of laboratory demonstrations.

Course Syllabus

Please note that the University of Surrey reserves the right to update and alter these courses – please check our website for updates

Introduction and Antenna Fundamentals I and II – Dr Tim Brown

An introduction to the whole course and its structure. What is an antenna? Why does antenna design and propagation modelling matter? Examples of applications in this regard. Overview of relevant textbooks in the field.

Brief introduction to Maxwell's equations, Poynting Vector, Plane waves, Hertzian Dipole. Isotropic radiator. Definitions of gain, radiation resistance, effective area, link budget and far field criteria, impedance and reflection coefficient. Polarisation, Basic wire antennas: dipole, loop. Helix antennas.

Antenna Characterisation Design Lab – Dr Tim Brown

Brief introduction to how antennas are designed characterised. To have a hands on experience in the laboratory with building and testing a linear wire antenna.

Types of Antennas and Introduction to Arrays – Dr Tim Brown

Following the introduction to antennas, this session will cover a brief introduction to the different types of antennas such as a Uda-Yagi antenna, Horn Antenna, helical antennas, microstrip antenna, slot antenna, Reflector Antennas and others. It will give particular attention to the concept of array antennas where multiple antenna elements can be combined. This will include 1-D and 2-D array antennas.

Propagation Fundamentals – Dr Tim Brown

Free space propagation, Scales of Variation in Mobile Systems, Path loss, Shadowing, Fast Fading. Reflection - Specular reflection. Fresnel coefficients, polarisation effects. Rough and random surfaces. Refraction - Refractive index. Snell's Law. Fresnel Transmission Coefficients. Multipath Effects. Introduction to stochastic, deterministic and empirical channel models.

Fixed Link Propagation Models – Dr Tim Brown

Plane earth loss, spherical earth effects. Diffraction and Huygen's Principle. Knife-Edge Diffraction. Fresnel Zones. Tropospheric Refraction. Path profiles - Line of sight versus non-line of sight. Tropospheric refraction - N-units. Effective earth radius. Ducting.

Slant Path Propagation for Fixed Satellite Links – Dr Tim Brown

This session provides an appreciation of propagation impairments relating to satellite links and focuses on fixed satellite links. The various impairments introduced in the troposphere and ionosphere are presented along with a description of the methods for assessing the impact of these effects. Reference will be made to the course book and appropriate ITU-R Recommendations. Some examples of calculations as well as measurement results will be

Diffraction Models – Dr Tim Brown

Multiple knife edge diffraction. Approaches to modelling diffraction including Deygout method, Causebrook Correction and Giovanelli method.

Mobile Systems Overview, Microcells and Macrocells – Prof Simon Saunders tbc

Overview of Mobile Systems - Cell Types.

Narrowband Fast Fading – Rayleigh and Rice fading. Outage probability, bit error rate effect. Doppler spread and channels with memory.

Macrocells - Empirical: power law, clutter factor, Okumura/Hata. Theoretical: Multiple Building Diffraction, COST-231 Walfisch-Ikegami, flat edge. Comparison of theoretical and empirical models.

Shadowing - Statistics. Availability at cell edge and over cell area.

Microcells - Empirical: Dual slope, attenuation factor.

Indoor Propagation – Prof Simon Saunders tbc

Picocells – Propagation in buildings and other enclosed spaces.

Femtocells – Challenges in propagation over a small proximity.

Propagation in the Troposphere – Dr Richard Rudd – Aegis Systems Ltd

The impact of the troposphere on terrestrial propagation paths. Temporal variability and radio-meteorology. Tidal fading and other challenges. The work of ITU-R Study Group 3.

Wire Antennas Old and New, Small Antennas – Prof Mike Underhill

Hertzian dipole. Half wave dipole. Folded dipole. Baluns. Resonant and non-resonant antennas. Antenna matching. Arrays, Yagi-Uda, broadside. Rhombic, helical. Mobile Station Antennas: - Monopole. Loading with capacitance and inductance. Loops, Helicals. Planar inverted F antennas. Base Station Antennas: - Vertical gain. Collinear. Sector antennas. Corner reflectors. Printed arrays.

Laboratory Demonstrations – Prof Mike Underhill

Demonstration of small tuned loops and log periodic antenna, and microwave can antenna.

Antenna Simulations – CST Ltd.

A lecture presented by Computing Simulation Technology (CST) Ltd. covering an introduction to the methods of antenna simulation followed by plus a hands on laboratory session experimenting with CST's own design studio software.

Base Station Antennas – Prof Brian Collins – BSC Consulting

Antennas for mobile radio base stations. The relationship between network requirements and antenna design. Antennas for space and polarisation diversity, multi-band arrays and arrays with adjustable tilt. Practical considerations - weather resistance and power handling.

HF Antennas and Propagation – Prof Brian Collins – BSC Consulting

HF propagation: basics, effects of sunspot number, season, time of day and location, prediction methods.

HF antennas: matching the antenna to the medium, broadband antennas, broadcasting antennas, NVIS antennas, receiving antennas.

GPS Systems Antennas – Prof Brian Collins – BSC Consulting

The GPS satellite system and basic location concepts. Different types of antennas, measurement of antenna systems, antenna-radio modules. Integration of antennas into application devices, how to demonstrate application devices

Printed Mobile Antennas – Prof Brian Collins – BSC Consulting

Antennas for handsets and small wireless devices. Problems of size, efficiency and bandwidth, user interactions and SAR. The rapidly increasing pressures of complex device integration. Future directions.

The Lecturers

Professor Mike Underhill MA, PhD, FEng, FIET, FRSA joined the University in 1991 and was formerly Head of the Applied Electronics Research Group and Dean of Engineering. Previously, he worked for Philips Research Laboratories then as Technical Director for MEL-Philips and for Thorn EMI Sensors as Engineering Director. He has been involved in Defence Electronics (mainly H F Radio) since 1961 and EW and Radar and IR since 1980. His current research interests include low phase noise in oscillators and frequency synthesis, low jitter clocks and clock recovery, HF transmitting loops and associated electromagnetic theory, millimetric and satellite borne HF radar and ionospheric sounding. He holds about 50 patents in these and related fields and has published about sixty papers. He has been a Fellow of the Royal Academy of Engineering since 1993.

Prof Simon Saunders, BEng, PhD, FIET, CEng Simon is a specialist in the technology of wireless communications, with a technical and commercial background derived from senior appointments in both industry (including Philips and Motorola) and academia (University of Surrey). He is an adjunct professor at Trinity College Dublin and Access Technology Principal at Google.

As co-founder and Director of Technology for independent wireless strategy advisory firm Real Wireless, he was responsible for overall technical capability and direction, providing independent wireless expertise and advice to operators, regulators, technology and law firms and wireless users. Customers included Ofcom, Cisco, European Commission, Virgin Media, TalkTalk, Inmarsat and many others.

He is an author of over 150 articles, books and book chapters. He has acted as a consultant to companies including BAA, BBC, O2, Ofcom, BT, ntl, Mitsubishi and British Land and was CTO of Red-M and CEO of Cellular Design Services Ltd and has acted as an expert witness in legal proceedings in England and the US. Simon speaks and chairs a wide range of international conferences and training courses and has invented over 15 patented wireless technologies. Particular expertise includes in-building wireless systems, radiowave propagation prediction, smart antenna design and mobile system analysis. He has served on technical advisory boards of several companies, was Visiting Professor to the University of Surrey, member of the industrial advisory board at University College London, founding chairman of Small Cell Forum (formerly Femto Forum), which he chaired from 2007-12 and a member of the Ofcom Spectrum Advisory Board from 2007-14.

Dr Tim Brown CEng, PhD, MIET is a lecturer at the University of Surrey who has had several years of experience at the University as well as industrial experience with Nortel Networks and Nokia Mobile Phones. Tim also obtained his PhD in antennas for mobile at Surrey. After spending over two years of postdoctoral research at Aalborg University, Denmark, he has developed long term experience in antennas and propagation modelling for mobile and wireless applications. Applications of Tim's research include radar, 5G mobile, radio frequency identification and Internet of things applications.

Prof Brian Collins BSc(Eng), CEng, FIET, MIEEE was Technical Director at CSA Ltd where he spent 40 years designing antennas for a wide variety of terrestrial communications and broadcasting applications for major international civil and military users. He then worked for 10 years with Antenova Ltd on the design of small antennas for consumer devices. Brian operates his own consultancy company which is involved in a wide variety of projects in North America, Europe and Asia. He is a Visiting Professor in the School of Electronic Engineering and Computer Science at Queen Mary, University of London, and is well known as an author and conference speaker.

Dr Richard Rudd, CEng, PhD, MIET is a Principal Consulting Engineer at Plum Consulting, specialising in propagation modelling and measurement, and in broadcast planning issues. Prior to joining Plum Consulting, Richard was at the BBC Research Department where he was concerned with network planning and propagation studies. Richard has been responsible for a wide range of empirical and theoretical studies embracing in-building propagation, wideband mobile channel sounding and time-variability on trans-horizon paths. He has been a member of the UK delegation to ITU-R Study Group 3 for many years, and is one of the authors of the IET textbook "Propagation of Radiowaves".

Modular MSc via Short Courses

By reading for a Masters degree on a flexible part-time basis delegates are able to continue with their working careers and still gain a universally recognised qualification. **Antennas and Propagation** can also form part of the "MSc in Electronic Engineering" via Short Courses. The purpose of the programme is to encourage those working in industry to continue with their professional development without necessitating an expensive career break. The modular approach means that students can choose their own pace of study, to fit in with their work commitments. An attendee can elect to undertake assessment for this course should he or she so wish. These assessments are mainly by examination.

15 credits towards the MSc in Electronic Engineering can be awarded once the student has successfully completed the modules associated with this course.

Reading List

S. Saunders, A. Aragon-Zavala, *Antennas and Propagation for Wireless Communication Systems*, J. Wiley & Sons. 2007, Second Edition, ISBN 978-0-470-84879-1.

K. Boyle, Y. Huang, "Antennas from theory to practice", 2008, Wiley, UK, ISBN 978-0-470-51028-5

<http://www.ee.surrey.ac.uk/Personal/D.Jefferies/teaching.html> (With several useful links)

Constantine A. Balanis, *Antenna Theory & Design*. 3rd edition, J. Wiley & Sons, 1997. ISBN 978-0-471-66782-7

John D. Kraus, *Antennas*, 3rd edition, McGraw-Hill, 2001. ISBN 978-0-071-12240-5

Parsons, JD, *The Mobile Radio Propagation Channel*, John Wiley & Sons, Second Edition, 2000, ISBN 978-0-471-98857-1

Hall, M.P.M., Barclay, L.W., Hewitt, M.T., (eds), *Propagation of Radiowaves*, London, IEE, 1996. 0852968191

Modules

Courses currently participating in the Modular Masters Programme are listed below.

- Antennas and Propagation
- 5G Mobile Communications
- Digital Signal Processing
- IP Networking Protocols and Technologies
- Microwave Engineering
- Mobile Communications and Technologies
- Emerging Techniques in Mobile Communications
- Radar and Remote Sensing
- RF Circuit and System Design (2 module course over one week plus distance learning)
- Satellite Communications
- Smart Cities
- Spacecraft Systems Design

A full explanation of how the short course MSc works is given on our website.
www.ee.surrey.ac.uk/CE/

Price

Price per person, including lunch, refreshments and printed course notes

Price per person, including lunch, refreshments and printed course notes:

£1750 - Early bird rate for registration received by 30 September 2017

For IET Members (proof of membership needed)

£1650 - Early bird rate for payment received by 30 September 2017

For Registrations received after 30 September 2017

£1850

Please note that we do not charge VAT as we are an educational establishment. This makes the price of this course very competitive!

Terms and Conditions

Delegates can make a provisional registration for a course by telephone or email. However bookings are only acknowledged formally once payment has been received.

Cancellations notified in writing ten working days before the event

We charge a cancellation fee of 35% of the standard rate. If we have already received payment we refund 65% of the full fee.

Cancellations within 10 working days before the event

We charge these at the full rate and do not give refunds

Substitutions

You can make substitutions at any time before the event.

Cancellation by the University

We reserve the right to cancel any course because of insufficient numbers or for other reasons beyond our control.

Proof of payment

Registrations must come with a valid purchase order, credit card payment or cheque.

ANTENNAS AND PROPAGATION TIMETABLE

30 October – 3 November 2017

<i>Time</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>
	Dr Tim Brown	Dr Tim Brown	Prof Mike Underhill	Prof Simon Saunders	Prof Brian Collins, BSC Consulting
09:00	Introduction and Antenna Fundamentals I	Propagation Fundamentals	Wire Antennas Old and New	Mobile Systems Overview	HF Antennas and Propagation
10:30	Coffee	Coffee		Coffee	Coffee
	Dr Tim Brown	Dr Tim Brown	Prof Mike Underhill	Prof Simon Saunders	Prof Brian Collins, BSC Consulting
11:00	Antenna Fundamentals II	Fixed Link Propagation Models	Small Antennas	Macrocell and Microcell Propagation	Base Station Antennas
12:30	Lunch	Lunch	Lunch	Lunch*	Lunch
	Dr Tim Brown	Dr Tim Brown	Prof Mike Underhill	Prof Simon Saunders	Prof Brian Collins, BSC Consulting
13:30	Antenna Characterisation and Design Lab	Slant Path Propagation for Fixed Satellite Links	LABS Demonstrations*	Indoor Propagation	GPS Systems Antennas
15:00	Tea	Tea	Tea	Tea	Tea
	Dr Tim Brown	Dr Tim Brown	CST Ltd.	Dr Richard Rudd Plum Consulting Ltd	Prof Brian Collins, BSC Consulting
15:30	Types of antennas and intro to Arrays	Diffraction Models	Antenna Simulation Laboratory*	Propagation in the Troposphere	Printed and Mobile Antennas
17:00	Finish	Finish	Finish	Continued extra lab time*	Finish
17:30				Finish 6:00-6:30pm	
19:00				19:15 Course Dinner	

*Please note the slightly different arrangement for the Thursday session, which will have also a shorter lunch break. Two separate groups will be created during these two afternoon sessions with the following schedule for groups A and B:

Group A:

CST simulation lab from 1300 to 1600, break from 1600-1615, then LABS demo from 1615-1745.

Group B:

LABS demo lab from 1330 to 1500, break from 1500-1600, then CST simulation lab from 1600-1900.

Revised 17 October 2016

University of Surrey
Faculty of Engineering and Physical Sciences
Short course on Antennas and Propagation 7-11 November 2016
One person per form only (forms may be photocopied)

Conditions of Booking	REGISTRATION (Please complete in CAPITALS)
<p>Application forms should be completed and returned to the address below and must be accompanied with the correct payment. Attendance at the event will only be confirmed on receipt of the full payment.</p>	<p>Family Name _____ Title: (Mr, Mrs, Miss etc) _____</p> <p>First Name _____ Job Title _____</p> <p>Name of Organisation (for name badge) _____</p> <p>_____</p> <p>Address for Correspondence _____</p> <p>_____</p> <p>Town/City _____</p> <p>Postcode _____ Country _____</p> <p>Contact Telephone _____ Fax _____</p> <p>Email _____</p> <p>Do you have any dietary or other requirements? _____</p> <p>Previous Experience</p> <p>Beginner <input type="checkbox"/> Intermediate <input type="checkbox"/> Advanced <input type="checkbox"/></p> <p>Approved By (please print): _____</p> <p>Position in Company: _____</p> <p>Signature: _____ Date: _____</p>
<p>Cancellations notified in writing ten working days before the event; we charge a cancellation fee of 35% of the standard rate. If we have already received payment we refund 65% of the full fee.</p> <p>Cancellations within 10 working days before the event; We charge these at the full rate and do not give refunds. If no written notice of cancellation is received, no refund can be made. The University of Surrey reserves the right to cancel any event. In this case, the full fee will be refunded unless a mutually convenient transfer can be arranged. Details of event changes or cancellations are available by phoning +44 (0)1483 686040</p> <p>Name Substitutions may be accepted following consultation with Barbara Steel, Continuing Education Manager Tel: +44 (0) 1483 686040 Email: b.steel@surrey.ac.uk</p> <p>Delegates with Special Needs The University aims to offer fully accessible events to all of its delegates. Please help us to accommodate any individual needs that you may have by attaching a note to the registration form. We will contact you to discuss this as necessary.</p> <p>Data Protection Information provided by you on this form will be processed by the University of Surrey and used for the purpose of the goods and services ordered by you, and for billing accounts.</p> <p>The University of Surrey is not, as a body responsible for the views or opinions expressed by individual authors or speakers.</p> <p>Complete and return this form to: Barbara Steel Faculty of Engineering and Physical Sciences University of Surrey Room 03 BB 04 Guildford Surrey GU2 7XH Fax: +44 (0) 1483 686041</p> <p>For all enquiries telephone +44 (0) 1483 686040 or email b.steel@surrey.ac.uk</p> <p>University of Surrey VAT reg No: GB 688 953 065</p> <p>CE Website: www.surrey.ac.uk/ee/pd</p>	<p style="background-color: black; color: white; padding: 2px;">FEES AND CHARGES (Please complete the appropriate box)</p> <p>Fees include attendance at the sessions, a hard copy of the course notes, morning and afternoon refreshments, lunch each day. Please note that we do not charge VAT.</p> <p>Charge per person</p> <p>EARLY BIRD REGISTRATION RATE for registrations received before 30 September 2017</p> <p>IET Member £1650 <input type="checkbox"/> Non Member £1750 <input type="checkbox"/></p> <p>STANDARD REGISTRATION RATE for registrations received after 30 September 2017</p> <p>£1850 <input type="checkbox"/></p> <p>IET Membership Number (if applicable) _____</p> <p style="background-color: black; color: white; padding: 2px;">PAYMENT DETAILS</p> <p>Payment must accompany this registration from. Registration will only be confirmed on receipt of full payment.</p> <p>Please indicate the method of payment:</p> <p>Cheque <input type="checkbox"/> Credit Card <input type="checkbox"/> Purchase Order <input type="checkbox"/> Bank transfer <input type="checkbox"/></p> <p>Cheques should be made payable to "University of Surrey" and crossed</p> <p>If paying by credit card please use the online store on:</p> <p>http://store.surrey.ac.uk/</p> <p>Please put your company's VAT No _____</p>