UNIVERSITY OF SURREY

Faculty of Engineering and Physical Sciences

A Continuing Education Course on

RF Circuit and Systems Design

1-5 July 2013

Enquiries to:

Continuing Education Office, Room 03 BB 04
Faculty of Engineering and Physical Sciences
University of Surrey, Guildford, Surrey, GU2 7XH
Tel: 44 (0)1483 686040 Fax: 44 (0)1483 686041
Email: B.Steel@surrey.ac.uk

Website: www.surrey.ac.uk/ee/pd

Overview

The course has been specifically designed to cover the major elements relevant to engineers working or starting out in the RF field and should provide them with the expertise required to excel in this, their chosen field. By joining some of the foremost experts in the field of RF engineering delegates will quickly be given the tools to get to grips with the major aspects of RF Circuit & System Design.

Who is this course for?

This course is intended for delegates wishing to consolidate and upgrade their RF knowledge to improve their effectiveness in the radio industry. Delegates will obtain an understanding of the technologies behind transmitter and receiver design including small signal RF amplifiers, synthesisers and PA design. The format of the course is such that even those with only a rudimentary understanding of the topic will quickly be brought up to speed. The course material progresses to an advanced level equivalent to that required to an MSc module. This course can also form part of the Modular MSc in Electronic Engineering. Please contact the CE office for further details. Numbers on this course are limited to 16 in order to give ample time to students in the CAD sessions.

PRICE

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

£1750 - Standard rate
£1600 – Early Bird Rate

£1525 – IET Early Bird Rate (proof of membership needed)

Early Bird rate is applicable for payments received with a purchase order, credit card payment or cheque before 1 June 2013

CONTACT DETAILS AND COURSE REGISTRATIONS

For further details or to make a registration contact:
Barbara Steel, CE Manager, Room 03 BB 04, Faculty of Engineering and Physical Sciences
University of Surrey, Guildford, Surrey, GU2 7XH, United Kingdom
Tel: +44(0)1483-686040, Fax: +44(0)1483-686041. Email: B.Steel@surrey.ac.uk

WEBSITE AND DETAILS OF OTHER SHORT COURSES

www.surrey.ac.uk/ee/pd

Course Syllabus

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

RF Transmission Lines – Dr Charles Free

An introduction to the properties and characteristics of transmission lines for use at RF will be given. Included in the presentation will be an introduction to the Smith Chart, and its uses in RF circuit design.

Planar Circuit Design – Dr Charles Free

The presentation will focus on microstrip, and the application of this technology for the design of RF circuits. The theory and design of some common matching circuits will be included, and the treatment extended to consider the design of planar lumped components.

RF Filters – Dr Charles Free

The essential theory pertaining to RF filters will be reviewed. The presentation will include the practical design of planar filters using microstrip technology, and the work extended to consider the application of recent multilayer planar techniques for RF and microwave filter design.

Intro to the Smith Chart, CAD Laboratory and Filters Laboratory – Dr Tim Brown and Erik Yngvesson

Before embarking on the laboratory, the Smith chart will be introduced, which will be used in the CAD laboratories throughout the course. Delegates will subsequently be provided with time to familiarise themselves with the functions of the Agilent ADS simulation environment, through the example design of a strip line filter. The ability of ADS to simulate the S-parameters over the desired frequency band will also be demonstrated.

RF Antennas and Propagation – Dr Tim Brown

Introduction to the key concepts of antennas: radiation patterns, gain, directivity, efficiency, polarisation, impedance. Simple free space propagation, plane earth loss. Snell's laws and ionospheric refraction. Diffraction loss and fade margin.

Transistor Circuits and Automatic Gain Control – Dr Tim Brown

Understanding bipolar junction transistors and field effect transistors and their usage in RF circuits. The long tail pair. Use of long tail pair in an automatic gain control. Applications of automatic gain control.

Receivers and Mixers I and II – Prof Mike Underhill

Regenerative, tuned radio and superheterodyne receivers. Mixer products. Noise and noise figure. Noise matching. Intermediate Frequency Filters. Mixers, intermodulation, phase noise effects in mixers.

RF Noise and Measurement Laboratory – Dr Tim Brown and Erik Yngvesson

Measurement and tuning of simple lumped element RF band pass filters. Measurement of RF noise and low noise amplifiers.

Software Radio Basics and Demo – Prof Mike Underhill

Receiver architecture. Signal representation. Modulation spectra. Bandwidth and noise. Digital filtering. Software defined radio receiver demonstration.

Oscillators and Frequency Synthesisers – Prof Mike Underhill

Phase noise and time jitter. Phase lock loop principles, frequency synthesis. Phase comparator noise and noise sources in the phase lock loop. Types of phase comparator. Divider techniques. The anti jitter circuit.

Vector Network Analyser Measurements – Nick Ridler
Network Analyser Basics; Coaxial Cables & Connectors; Calibration Methods; Calibration in Coaxial line; On-wafer Measurements Overview; On-wafer calibration

Dielectric Measurements – Bob Clarke

A review of RF and Microwave dielectric measurement techniques, both for permittivity and loss tangent, relating techniques to applications. The review will include resonance methods and measurement of Q-factor; dielectric resonators; waveguide cavities; open resonators; coaxial and waveguide transmission line methods; the admittance cell method for RF; and microwave methods for measuring dielectric properties on micron and nanometre scales.

Phase Lock Loop Laboratory – Dr Tim Brown and Erik Yngvesson

Experiment with phase lock loop frequency synthesiser.

CAD Multilayer Circuit Design – Dr Tim Brown and Erik Yngvesson

Simulation laboratory using the ADS environment with multilayer circuit design.

RF Power Amplifiers – Dr Peter King
Overview of power amplifiers (PAs). Which Technology? PA Non-linearity and effect on Waveform. PA Efficiency and Class. Introduction to Class AB. Introduction to Doherty. Highly Efficient PA Techniques. PA Architectures. Reliability and Thermal Considerations.

PA Linearisation – Dr Peter King

Why Linearise? Modelling Device Non-linearity. Linearisation Choices. Introduction to Polar Loop Transmitter. Introduction to Feed-Forward Linearisation. Introduction to Digital Pre-Distortion. Practical Considerations.

RF Amplifier Design – Prof Ian Robertson

This lecture introduces the classical principles behind small-signal RF amplifier design - matching, stability, DC biasing, gain and noise figure circles. The lecture then covers practical design in a range of technologies & applications.

CAD Amplifier Design Laboratory – Prof Ian Robertson

This CAD lab complements the lecture with a design example of an RF amplifier simulated using ADS with experimentation on amplifier matching, stability and design.

RFICs and MMICs – Prof Ian Robertson

This lecture introduces the key active and passive components for GaAs and Silicon IC design. The most common circuit topologies are introduced for amplifiers, mixers, oscillators, switches, variable attenuators and phase shifters. Finally, recent developments in millimetre-wave silicon designs are introduced.

Transceivers and Handsets – Prof Ian Robertson

This lecture considers the different architectures used for modern transmitters and receivers in mobile handsets. A number of practical solutions and chipsets are studied and some of the key off-chip RF components are considered - filters, the PA and switches (including MEMS).

The Lecturers

Dr Charles Free MSc PhD CEng MIEEE was formerly Reader in Microwave Technology in the Advanced Technology Institute (ATI) at the University of Surrey. After retiring at the end of 2009 he became a visiting research scientist in the ATI, where his research interests are in planar circuit and antenna design at microwave frequencies, and in the characterisation of materials at high mm-wave frequencies.

Dr Tim Brown CEng, PhD, MIET is a lecturer in RF, antennas and propagation at the University of Surrey who has had several years of experience at the University both as an undergraduate student and postgraduate researcher. During this time as a student, Tim specialised in antennas and propagation through his tuition and industrial experience with Nortel Networks and Nokia Mobile Phones, where his PhD title focussed on diversity antennas at the mobile. After spending over two years of postdoctoral research at Aalborg University, Denmark, he has developed long term experience in antennas and propagation for mobile and wireless applications and at present is actively researching in several applications of RF including RFID, NFC, wireless devices, UWB radar and antenna design. Tim is also the organiser of the MSc programmes in RF and microwave at the University.

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.

Erik Yngvesson MEng, MSc received the MEng degree in electronic engineering from the University of Edinburgh in 2004 and the MSc degree in RF and microwave engineering from the University of Surrey in 2011. He is currently working toward the PhD degree with the Centre for Communication Systems Research, University of Surrey. Between 2004 and 2010 he worked for Schlumberger and ST-Ericsson. His research interests include interference mitigation techniques in wireless networks and multiple-input-multiple-output communication systems. Erik was the recipient of the of the 2011 Rhode & Schwarz RF MSc prize for best overall performance in the area of RF technology.

Mr Nick Ridler FIET, SMIEEE, MinstP, CEng, CPhys, BSc has spent 30+ years working in both industrial and government scientific research laboratories. He is currently employed by the UK's National Physical Laboratory and is Lead Scientist/Principal Research Scientist responsible for RF and microwave measurement activities. His current research interests include measurements at millimetre and sub millimetre wavelengths, and, measurements on high-speed Printed Circuit Boards (PCBs). Nick is currently Chair of the IEEE's "Microwave Measurements" Technical Committee; President of IEEE MTT-S Automatic RF Techniques Group (ARFTG); Chair of the IET's "RF & Microwave Technology" network; Chair of the IEEE P1785 Working Group on "Waveguides for Millimeter and Submillimeter Wavelengths"; Chair of the Millimetre-wave Users Group; and, Chair of ANAMET. Nick has authored or co-authored over 160 papers, articles and reports on RF and microwave measurement and has acted as General Chair and Technical Program Chair for several international (IEEE) conferences on these subjects. He is listed in *Who's Who in Science and Engineering.*

Bob Clarke joined NPL in 1969 after receiving an honours degree in Physics from Bristol University. He took up a post in the RF and Microwave Measurements Group at NPL and has since worked on a wide variety of microwave metrology projects, many of them concerned with microwave dielectric measurements. Today he is a Principal Research Scientist in the Materials Division at NPL where he is a leading metrologist in the field of RF and Microwave electromagnetic materials. During his career, besides specialising in and acting as a PhD examiner in this field, he has also led projects on impedance standards, SQUID metrology, mode-stirred chambers for EMC metrology, electromagnetic field-strength mapping, and the interaction of electromagnetic radiation with biological tissues, covering both health and safety and medical treatment aspects. He has published over 40 papers on RF and Microwave measurement, has contributed chapters to books on dielectric metrology and is the major contributor to and editor of an NPL Good Practice Guide on dielectric measurements.

Dr Peter King is the owner of Advanced Wireless Technology Ltd, a small RF engineering company based in Surrey providing RF module design, build & test, and RF consultancy services. He has over 20 years experience of end-to-end radio systems, radio propagation, antennas, radio transceiver architecture design and RF circuit design of receivers, transmitters, phase locked loops & power amplifiers (including linearisation) applied to the mobile, satellite, aviation, defence and other wireless radio communications industries.

Peter has worked for over 10 years on mobile phone base stations (notably for TDD & FDD LTE and WiMAX networks, GSM, UMTS and CDMA) and handsets (GSM, DCS, PCS, EDGE, GPRS and UMTS) for multiple leading vendors (AceAxis, Nortel, Siemens, Samsung, TTP Communications, Airspan and Lucent), where he gained expertise in radio transceiver architecture design and RF circuit design. He has worked for 7 years on satellite communications (particularly the LMS-MIMO propagation channel, Inmarsat BGAN/SBB, ESA IRIS and various Ku/Ka band systems) performing systems analysis, radio propagation research, airborne terminal design and managing large EU research projects, both in industry and academia (Thales Avionics and the University of Surrey). Further, he has worked on various fixed wireless access, cable TV, in-flight entertainment, NFC and defence systems, carrying out end-to-end RF system design, co-location interference studies, radio transceiver architecture design and RF circuit design. Peter holds a PhD in mobile-satellite radio propagation, an MSc in Mobile & Satellite Communications both from the University of Surrey, and a BSc in Electronic Engineering from the University of Essex.

Prof Ian Robertson holds the University of Leeds Centenary Chair in Microwave and Millimetre-Wave Circuits and is Head of the School of Electronic & Electrical Engineering. He has published over 400 papers in the area of microwave and millimetre-wave engineering as well as co-editing the well-known book RFIC and MMIC Design and Technology. He was elected Fellow of the IEEE in 2012 for contributions to MMIC design and millimetre-wave system-in-package technology. He was General Technical Programme Committee Chair for the 2011 European Microwave Week – the premier European event in microwave and millimetre-wave engineering. He has held over £3M in grants as PI and led 5 major EPSRC-funded collaborative projects. He currently leads an IeMRC-funded project in 3D microwave and millimetre-wave components with Loughborough and Imperial College.

RF Systems and Circuits Short Course Provisional Timetable
1-5 July 2013

Day	0900-1030	1100-1230	1330-1500	1530-1700	1700-1830
Monday	RF Transmission Lines **Dr Charles Free**	Planar circuit design **Dr Charles Free**	RF Filters **Dr Charles Free**	The Smith chart and introduction to CAD laboratory **Dr Tim Brown and Erik Yngvesson**	CAD Laboratory Filters **Dr Tim Brown and Erik Yngvesson**
Tuesday	RF Antennas and Propagation **Dr Tim Brown**	Transistor Circuits and Automatic Gain Control **Dr Tim Brown**	Receivers and mixers I **Prof Mike Underhill**	Receivers and mixers II **Prof Mike Underhill**	RF Noise and Measurement Laboratory **Dr Tim Brown and Erik Yngvesson**
Wednesday	Software Radio Basics and Demo **Prof Mike Underhill**	Oscillators and Frequency Synthesisers. **Prof Mike Underhill**	Vector Network Analyser Measurements **Nick Ridler**	Dielectric Measurements **Bob Clarke**	Phase Lock Loop Laboratory **Dr Tim Brown and Erik Yngvesson**
Thursday	CAD Multilayer Circuit Design **Dr Tim Brown and Erik Yngvesson**	RF Power Amplifiers **Dr Peter King**	Power Amplifier Linearisation **Dr Peter King**	RF Amplifier Design **Prof Ian Robertson**	CAD Amplifier Design Laboratory **Prof Ian Robertson**
Friday	RFICs and MMICs **Prof Ian Robertson**	Transceivers and Handsets **Prof Ian Robertson**	Tutorial/Lab Visit **Dr Charles Free**		

Updated March 2013

Coffees, Teas and a hot lunch will be provided each day.

Please note that this timetable is provisional and the University of Surrey reserves the right to make changes.

RECOMMENDED READING

Pozar, D. Microwave Engineering 3rd edition, Wiley 2005
Collins, G.W. Fundamentals of Digital Television Transmission 2001 Wiley USA
Kraus, J.D. Antennas for all applications 3rd edition, 2002
Hutson, G.H. , Shepherd, P.J. & James Brice, W.S, Colour Television.
D.M.Pozar, "Microwave and RF Wireless Systems" 2000, Wiley, UK, ISBN 978-0-471-32282-5

Y.Huang, K.Boyle, "Antennas, From Theory to Practice" 2008, Wiley, UK, ISBN 978-0-470-512-285

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Short course on RF Circuits and Systems Design 1-5 July 2013
One person per form only (forms may be photocopied)

Conditions of Booking

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.

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.
If no 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

Name Substitutions may be accepted following consultation with Barbara Steel, Continuing Education Manager
Tel: +44 (0) 1483 686040
Email: b.steel@surrey.ac.uk

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.

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.

The University of Surrey is not, as a body responsible for the views or opinions expressed by individual authors or speakers.

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CE Website: www.surrey.ac.uk/ee/pd

REGISTRATION (Please complete in CAPITALS)

Family Name _____ Title: (Mr, Mrs, Miss etc) _____

First Name _____ Job Title _____

Name of Organisation (for name badge) _____

_____

Address for Correspondence _____

_____

Town/City _____

Postcode _____ Country _____

Contact Telephone _____ Fax _____

Email _____

Do you have any dietary or other requirements? _____

Previous Experience

Beginner ☐ Intermediate ☐ Advanced ☐

Approved By (please print): _____

Position in Company: _____

Signature: _____ Date: _____

FEES AND CHARGES (Please complete the appropriate box)

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.

Charge per person

EARLY BIRD REGISTRATION RATE (on or before 1 June 2013)

IET Member £1525.00 ☐ Non Member £1600.00 ☐

STANDARD REGISTRATION RATE (after 1 June 2013)

Non Member £1750 ☐

IET Membership Number (if applicable) _____

PAYMENT DETAILS

Payment must accompany this registration from. Registration will only be confirmed on receipt of full payment.

Please indicate the method of payment:

Cheque ☐ Credit Card ☐ Purchase Order ☐ Bank transfer ☐

If paying by credit card please telephone the office on 01483 686040. We will need card number, 3-digit security code, name of person on card and address. A receipt will be issued for the credit card payment.