

# School of Electrical Engineering and Telecommunications

## Faculty of Engineering

### University of New South Wales

#### Postgraduate Study – Coursework Programs (8539, 8538, 5338)

The formal postgraduate coursework programs offered by the School of Electrical Engineering & Telecommunications within the Faculty of Engineering are:

**Master of Engineering Science Extension (program code: 8539)**

- duration: 2 years ,
- Units of Credit: 96

**Master of Engineering Science (program code: 8538)**

- duration: 1.5 years
- Units of Credit: 72

**Graduate Diploma of Engineering Science (program code: 5338)**

- duration: 1.5 years
- Units of Credit: 60

The School of Electrical Engineering and Telecommunications offer the following areas of Specialisations (PLANS) for each of the above programs

<i>Energy Systems</i>	[plan ELECMSxxxx]
<i>Microelectronics &amp; Microsystems</i>	[plan ELECNSxxxx]
<i>Signal Processing</i>	[plan ELECGSxxxx]
<i>Systems and Control</i>	[plan ELECLSxxxx]
<i>Telecommunications</i>	[plan TELEASxxxx]

[ xxxx refers to the program code]

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**Program outlines:**

<b>The Master of Engineering Science Extension (program code: 8539)</b> <b>- 2 years Total: 96 Units of Credit</b>		
Maximum 24 UOC of Professional Development courses (Candidates with a 4 year Bachelor degree in Electrical Engineering or Telecommunications and a sound knowledge in the relevant Professional Development courses may be granted up to 24UOC of advanced standing for these courses.)	Choose from attached list A on page 3	
At least 24 UOC from one of the Specialisations area	Choose from attached list B on page 4	
12-24 UOC of Engineering & Technical Management courses	Choose from attached list D on page 5	
Maximum 12 UOC of courses from other specialisation courses	Choose from attached list B on page 4	
12 or 24 UOC of project reports	See the attached list C on page 5 for project course codes. See the appendix B on page 15 for supervisors and research project areas	

<b>The Master of Engineering Science (program code: 8538)</b> <b>- 1.5 years Total: 72 Units of Credit</b>		
Maximum 24 UOC of Professional Development courses (Candidates with a 4 year Bachelor degree in Electrical Engineering or Telecommunications and a sound knowledge in the relevant Professional Development courses may be granted up to 24UOC of advanced standing for these courses.)	Choose from the attached list A on page 3	
At least 24 UOC from one of the Specialisations area	Choose from the attached list B on page 4	
12-24 UOC of Engineering & Technical Management courses	Choose from attached list D on page 5	
Maximum 12 UOC of courses from other specialisations courses or 12 UOC of project reports	Choose from the attached list B on page 4 for other specialisations. See the attached list C on page 5 for project course codes. See the appendix B on page 15 for supervisors and research project areas	

<b>The Graduate Diploma of Engineering Science (program code: 5338)</b> <b>- 1.5 years Total: 60 Units of Credit</b>		
Maximum 24 UOC of Professional Development courses (Candidates with a 4 year Bachelor degree in Electrical Engineering or Telecommunications and a sound knowledge in the relevant Professional Development courses may be granted up to 24UOC of advanced standing for these courses.)	Choose from the attached list A on page 3	
At least 18 UOC from one of the Specialisations area	Choose from the attached list B on page 4	
6 - 18 UOC of Engineering & Technical Management courses	Choose from attached list D on page 5	

## Professional Development courses (List A)

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
ELEC3104	Digital Signal Processing	6	1
ELEC4601	Digital and embedded system	6	2
ELEC4602	Microelectronics Design & Technology	6	2
ELEC4611	Power System Equipment	6	1
ELEC4612	Power System Analysis	6	2
ELEC4613	Electrical Drives	6	2
ELEC4614	Power Electronics	6	1
ELEC4621	Advanced Digital Signal Processing	6	1
ELEC4622	Multimedia Signal Processing	6	2
ELEC4631	Continuous Time Control System Design	6	1
ELEC4632	Computer Control Systems	6	2
ELEC4633	Real Time Engineering	6	1
PHTN4661	Optical Circuits & Fibres	6	1
PHTN4662	Photonics Networks	6	2
TELE3118	Network Technologies	6	1 & 2
TELE3119	Trusted Networks	6	2
TELE4651	Wireless Communication Technologies	6	2
TELE4652	Mobile and Satellite Communications System	6	2
TELE4642	Network Performance	6	1

\*The course description of each course is printed on pages 6-14.

## Specialisation areas and courses (List B)

### Energy Systems Specialisation Courses:

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
ELEC9711	Advanced Power Electronics	6	2
ELEC9712	High Voltage Systems	6	2
ELEC9713	Industrial & Commercial Power Systems	6	1
ELEC9714	Electricity industry Planning & Economics	6	1
ELEC9715	Electricity industry Operation & Control	6	2
ELEC9716	Electrical Safety	6	1

### Microsystems and Microelectronics Specialisation Courses:

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
ELEC9701	Mixed Signal Microelectronics Design	6	2
ELEC9702	RF IC design	6	1
ELEC9703	Microsystem Design & Technology (offered in both modes – on campus and distance learning)	6	2
ELEC9704	VLSI Technology	6	1
ELEC9705	Quantum Devices	6	2

### Signal Processing Specialisation Courses:

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
ELEC9721	Digital Signal Processing & Applications	6	2
ELEC9722	Digital Image Processing Systems	6	1
ELEC9723	Speech Processing	6	1
ELEC9724	Audio & Electroacoustics	6	2

### Systems and Control Specialisation Courses:

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
ELEC9731	Robust & Linear Control Sys.	6	1
ELEC9732	Analysis & Design of Non-linear Cont.	6	2
ELEC9733	Real Time Computing & Control	6	1
ELEC9734	Biomedical Instrumentation & Informatics	6	2

### Telecommunications Specialisation Courses:

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
TELE9751	Switching Systems Architecture (core course)	6	1
TELE9752	Network Operations & Control (core course)	6	2
TELE9753	Advanced Wireless Network (core course)	6	1
TELE9754	Coding & Information Theory (core course)	6	2
TELE9755	Microwave circuits, theory and techniques	6	2
TELE9756	Advanced Networks	6	2
TELE9757	Quantum Communications	6	1

## Project Reports (List C)

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
ELEC9771	Project Report A** (see p.14 for research areas)	6	1 & 2
ELEC9772	Project Report B**	6	1 & 2
ELEC9971	Project Report A extended**	6	1 & 2
ELEC9972	Project Report B extended**	6	1 & 2

\*\*On approval of the program authority and also see p.14 for research areas)

Project Reports must be conducted over 2 sessions:

- For candidates in the 8539 program attempting 24 UoC of Project Report, course codes ELEC9771 and ELEC9971 must be used for their first session of enrolment and course codes ELEC9772 and ELEC9972 for the second session.
- For candidates in the 8538 or 8539 program attempting 12 UoC Project Report, course codes ELEC9771 must be used for their first session of enrolment and course codes ELEC9772 for the second session.

## Engineering and Technical Management courses offered by Faculty of Engineering (List D)

<i>Course Code</i>	<i>Course Name</i>	<i>UoC</i>	<i>Semester</i>
GSOE9210	Engineering Decision Structures	6	S1
GSOE9420	Project Management in Engineering and Research	6	S1 & S2
GSOE9712	Engineering Statistics and Experimental Design	6	S1 & S2
GSOE9747	Innovation and Commercialisation for Engineers	6	S1 & S2
GSOE9810	Process and Product Quality in Engineering	6	S1 & S2
GSOE9820	Engineering Project Management	6	S1 & S2
GSOE9830	Economic Decision Analysis in Engineering	6	S1 & S2
GSOE9840	Process Improvement and Maintenance Engineering	6	S1 & S2
ELEC4445	Entrepreneurial Engineering	6	S2

## Appendix A

### Course Descriptions

#### *Specialisation Courses*

##### **ELEC9701 Mixed Signal Microelectronics Design**

UOC6 HPW3

The aim of the course is to enable the student to design advanced analogue, digital and mixed signal microelectronic circuits and to enable self-guided continuing learning in the advancing field of microelectronics. Topics covered include: special IC processes, scaling, matching, parasitics, wires, advanced transistor modelling, frequency analysis, cascode OTAs, fully-differential circuits, filters, sigma-delta converters, logic effort, advanced logic families, TSP registers, arithmetic circuits, timing, clock distribution, self-timed systems, mixed analogue-digital design, current research.

##### **ELEC9702 RFIC Design**

UOC6 HPW3

The objective of this course is to provide postgraduate students with an advanced understanding of designing RF integrated circuits in state-of-the-art CMOS technology with the ultimate purpose of integrating the entire transceiver on an IC chip. This course will build on existing knowledge from undergraduate courses on RF electronics with presumed knowledge of transmission line theory, Smith Chart and S-parameters. Course will cover the design of fundamental RF building blocks for communication systems which includes: mixers, low noise amplifiers, power amplifiers, oscillators and phase-lock loops. Noise and nonlinearity considerations in these building blocks will be treated in detail. Implications of each RF building block performance on the overall performance of an integrated communication system will be studied.

##### **ELEC9703 Microsystems Design and Technology**

UOC6 HPW3

Interdisciplinary overview of MST (MicroElectroMechanical Systems - MEMS). Transducer definition: Sensors and Actuators. Micromachining techniques including silicon bulk micromachining, silicon surface micromachining, stiction problems, bonding processes, LIGA technique, micromachined mould template and electroplating, sealed cavity formation, stereolithography, chemical mechanical polishing for planarisation, electric discharge micromachining, laser micromachining, focused ion beam micromachining. Properties of materials for micromachining. Mechanical transducers. Optical transducers. Thermal transducers. Magnetic transducers. Chemical and biological transducers. Microfluidic devices. Circuit interfaces to transducers. System considerations. Case studies. Technology trends.

##### **ELEC9704 VLSI Technology**

UOC6 HPW3

Introduction to silicon VLSI technology. Future trends in VLSI technology. Technology limitations. Basic technology modules include: crystal growth and wafer preparation; mask generation techniques; lithography; diffusion process; ion implantation; oxidation; etching techniques - wet etching and plasma etching; thin film deposition - epitaxial growth, chemical vapor deposition techniques, metallisation; clean room technology; Advanced process integration for CMOS, BiCMOS and Bipolar fabrication; Failure analysis techniques.

### **ELEC9705 Quantum Devices**

UOC6 HPW3

Quantum Devices provides a rigorous but accessible introduction to the working principles and the uncommon properties of Nano-engineered electronic devices, whose dynamics no longer obeys the laws of classical physics. Such devices are designed to be the building blocks of future quantum information and communication systems, by allowing to observe and manipulate individual electron charges, measure their spin state, and couple them to quantized electromagnetic fields.

### **ELEC9711 Advanced Power Electronics**

UOC6 HPW3

The topic to be covered in this course will include: resonant converters, converter circuit characteristic and system modeling, device selection and their modeling, thermal design, gate drive design, magnetic core selection and design, dynamic representation of DC-DC converters, control loops design, case studies of converter system designs.

### **ELEC9712 High Voltage Systems**

UOC6 HPW3

High voltage engineering and technology form an important area in power engineering. It deals mainly with electric insulation systems and processes that take place in power system equipment. In-depth knowledge in this area is essential for designers and operators of high voltage equipment and power utility engineers.

### **ELEC9713 Industrial and Commercial Power Systems**

UOC6 HPW3

The aim of the course is to provide practical knowledge on the design and operation of electrical distribution systems in large commercial buildings or industrial sites. Topics covered include: regulatory aspects; switchboards, cabling systems; transformers and switchgear; earthing systems; electrical safety issues including personnel protection and fire protection; protection of electrical systems (including both overcurrent and surge protection) and condition monitoring; lightning protection; electrical lighting systems; communication systems in buildings; emergency systems; energy efficiency and energy management; power quality and effects of voltage and current harmonics; power frequency magnetic fields and their impact in building and industrial sites.

### **ELEC9714 Electricity Industry Planning and Economics**

UOC6 HPW3

The nature of the electricity & gas industries; climate change and the electricity industry; objectives & options for restructuring; insights from electricity pricing theory; wholesale electricity market design; Australia's restructured electricity industry; National Electricity Market design & performance; the role of electricity networks in a restructured electricity industry including market representation, network pricing and network regulation; ancillary services; design & implementation of retail electricity markets; electricity industry regulation.

### **ELEC9715 Electricity Industry Operation and Control**

UOC6 HPW3

Induction to the evolving electricity industry drivers of restructuring, technological developments and environmental concerns, and their impact on power system operation. Conventional approaches and tools for economic dispatch, unit commitment, hydroscheduling, production costing, reliability measures and operations planning in traditional industry structures. Power system operation within restructured electricity industries-wholesale spot electricity markets, bilateral trading, forward markets and full retail competition. Operation of power systems with renewable energy resources.

### **ELEC9716 Electricity Safety**

UOC6 HPW3

This course covers the very broad and important area of electrical safety in domestic and industrial installations. Topic areas include, the effects of electric current passing through the human body; lightning hazards; protection of personnel: earthing and double insulation; protection of personnel: residual current detectors; effects of electric and magnetic fields and electromagnetic radiation; electrosurgical hazards; electrical fires and their investigation; electrical safety and the law; electrical safety in hazardous atmospheres: area classification; gas grouping; temperature classification; flameproof protection; intrinsic safety protection; increased safety protection; non-sparking protection; special protection; pressurization or purging protection; encapsulation, sand filled and oil filled protection; dust ignition proof equipment; cabling and terminations; certification, marking and quality control and maintenance requirements.

### **ELEC9721 Digital Signal Processing & Applications**

UOC6 HPW3

Least squares digital filter design and realisation, finite word length effects, random processes, adaptive filters, linear prediction, multi-rate signal processing, time-frequency analysis, sub-band transforms and wavelets. Applications may include: tone detection, noise reduction, pitch estimation, etc.

### **ELEC9722 Digital Image Processing Systems**

UOC6 HPW3

The fundamentals of digital image processing with topics selected from the following: image models and physical imaging systems; visual perception; rendering systems; linear filtering; linear transforms; mathematical morphology; compression; tomographic image reconstruction; inverse problems in imaging; image enhancement; edge detection; feature extraction; and geometric diffusion.

### **ELEC9723 Speech Processing**

UOC6 HPW3

Fundamentals of speech production, speech analysis: pitch and period extraction, formant estimation, voiced - unvoiced decision. Non-linear smoothing. Linear prediction. Inverse filtering. Implementation of speech/speaker recognition systems. Auditory modelling, auditory masking. Audio signal processing. Speech and audio compression. Compression standards. Speech enhancement.

### **ELEC9724 Audio & Electroacoustics**

UOC6 HPW3

The course is aimed at providing fundamental theory behind the processing of audio signals. Such knowledge is essential in understanding the processing of sound signals (speech and music) in both hardware (various audio equipment including microphones and amplifiers) and software (Digital Signal Processing). Topics covered will include: Acoustics, 1-D Digital Processing Concepts, Psychoacoustics, Microphones, Amplifiers, Digital Speech & Music systems, and Reverberation.

### **ELEC9731 Robust and Linear Control Systems**

UOC6 HPW3

Rationale for the study of linear methods. Continuous and discrete LTI systems (tf, zpk and ss), discrete-time approximations. Controllability, canonical forms, pole placement (state feedback design). Observability. Lyapunov stability applied to linear systems. Basic robustness (SISO), sensitivity and complementary sensitivity, classical loop shaping, SISO dynamic controller design using polynomial methods. Robustness (MIMO), singular value decomposition, loop shaping analysis and loop shaping (state feedback). Basic least squares theory as basis for LQR and LQE. The optimal linear regulator, discrete and continuous. Kalman filter and predictor (discrete, continuous). Advanced loop shaping, LTR (continuous time). Advanced robustness, disturbance rejection, H-infinity. Decoupled MIMO controller design. Recursive least squares identification.

### **ELEC9732 Analysis and Design of Nonlinear Controls**

UOC6 HPW3

The course is taught in two halves. The first half covers basic nonlinear control, design and analysis. The second half is devoted to robotic applications. The nonlinear control will cover topics drawn from analysis and design. Analysis includes: general state description of nonlinear systems, linearisation techniques, Lyapunov stability, constrained linear systems, constrained optimisation, multimode control. Design includes: actuator saturation, linearisation and gain scheduling, feedforward control, interactions and LQG control, sliding mode control, adaptive control. The above will be developed with illustrative simulation studies and CAD, and both physical modelling and systems identification will be covered. The robotics material will cover topics drawn from: manipulator kinematics and dynamics, velocity propagation and Jacobians, linear and nonlinear control of manipulators.

### **ELEC9733 Real Time Computing and Control**

UOC6 HPW3

Examines the implementation of modern control techniques and associated instrumentation using distributed computers. Practical hardware aspects, including measurement and actuation, data conditioning, acquisition and transmission, microprocessor devices, and other distributed computing components. Commercial realisations ranging from PLCs to full process control computing systems. Software: executive operating systems, concurrency, control algorithms, numerical problems, languages and development tools in the real-time context. Design of the man-machine interface using interactive computer display systems. The role of simulation and other CAD tools. Steps of engineering development from concept to commissioning. The viewpoint of industrial design is maintained throughout.

### **ELEC9734 Biomedical Instrumentation and Informatics**

UOC6 HPW3

Design and development of biomedical instrumentation for clinical measurement and biomedical research. Hardware and software design issues required to produce instruments which satisfy Australian and International standards for safety, performance and quality control. Tutorials and laboratories will be closely integrated so that design and analysis carried in tutorial sessions will be followed by testing and development in the laboratory sessions. A design project and/or case study will also be required as part of this course.

### **TELE9751 Switching Systems Architecture**

UOC6 HPW3

This course provides detailed knowledge of the design of equipment and protocols used to build communication networks such as the Internet. The course has five parts: 1. Switches: The motivations for switched networks, and the fabrics that provide the core switching function inside switches and routers. This includes time- and space-division switches, and all-optical switches. 2. Algorithms and techniques for implementing other functions of switches and routers, such as packet classification, buffering, and traffic management. 3. Protocols used between switches and routers, such as the Spanning Tree Protocol and bridges, signalling protocols, fast packet switching and tag switching. 4. Other internetworking devices, e.g. caches, load balancers, and layer 4/7 switches. 5. Design of networks in terms of dimensioning links and nodes (equipment) in order to achieve performance objectives. This course provides detailed knowledge of the design of equipment and protocols used to build communication networks such as the Internet. The course has five parts: 1. Switches: The motivations for switched networks, and the fabrics that provide the core switching function inside switches and routers. This includes time- and space-division switches, and all-optical switches. 2. Algorithms and techniques for implementing other functions of switches and routers, such as packet classification, buffering, and traffic management. 3. Protocols used between switches and routers, such as the Spanning Tree Protocol and bridges, signalling protocols, fast packet switching and tag switching. 4. Other internetworking devices, e.g. caches, load balancers, and layer 4/7 switches. 5. Design of networks in terms of dimensioning links and nodes (equipment) in order to achieve performance objectives.

### **TELE9752 Network Operations & Control**

UOC6 HPW3

This course introduces the principles, techniques, and tools used for the management of modern communication networks such as the Internet. The five major functional areas of network management are discussed: configuration management for configuring the hardware and software on network elements, performance management for measuring and controlling network performance, fault management for detecting and responding to fault conditions in the network, security management for securing and controlling access to resources in the network, and accounting management for tracking and logging network usage.

### **TELE9753 Advanced Wireless Network**

UOC6 HPW3

This course provides advanced knowledge of wideband wireless communication techniques to enable the students to design advanced wireless communication systems. It includes the topics of diversity techniques, multiple access and interference management, Wideband CDMA, Wideband OFDM, antenna arrays, multiple-input/multiple-output communications, spatial multiplexing, space-time processing and coding; and multiuser detection, opportunistic communication, multiuser waterfilling.

### **TELE9754 Coding & Information Theory**

UOC6 HPW3

This course provides advanced knowledge of error control coding technique and theories of information transmission mainly at the physical layer. It include the areas of: information theory, channel capacity, Error control coding techniques for wireless mobile channels, Turbo coding, LDPC coding with iterative decoding algorithms, iterative receivers and their application for wireless communications; Space-time coding and MIMO capacity.

### **TELE9755 Microwave Circuits, Theory & Techniques**

UOC6 HPW3

The general flow of the course is Applications, Systems, Components. Applications of microwaves: (terrestrial and satellite communications, radar, remote sensing, wireless). System requirements for elements are to be analysed. Propagation modes (TEM, TE, TM, quasi-TEM), attenuation, dispersion, S-parameters are parts of general fundamentals. Analysis of circuit components and MIC are to be introduced.

### **TELE9756 Advanced Networking**

UOC6HPW3

This course provides advanced knowledge of telecommunication networks currently being deployed or likely to be deployed in the future. It focus will be on material drawn from the recent research literature with a particular focus in the following three areas: network-to-network interface issues related to quality of service and reliability; cross-layer optimization issues related to network efficiency; and the control and management of mobility in networks.

## **TELE9757 Quantum Communications**

UOC6HPW3

This course is aimed at Graduate Engineers and Physicists wishing to understand the exciting new world of Quantum Communications. Quantum Communications and Quantum Networks are anticipated to be the core networking technologies of the 21<sup>st</sup> century. In fact these communication systems have already appeared in the commercial world in many variations. This course introduces the key concepts important for understanding, testing, analysing and improving the performance of quantum communication networks. It will have particular focus on actual quantum networks currently being deployed and the use of such networks for secure information transfer. Designed from an engineering perspective the course will first introduce the basic quantum physics that underlies quantum communication principles. It will then introduce and explore the key concepts that drive quantum communications such as Quantum Entanglement, Quantum Teleportation, The No Cloning Theorem, Quantum Cryptography; Privacy Amplification and Error Correction for Quantum Keys.

## **ELEC9771 Project Report A**

UOC6 HPW6

The project is done in a major area, in which it is offered under the supervision of an academic member of staff. Where the work is carried out externally a suitable co-supervisor may be required. Projects can take many forms such as the design and construction of experimental equipment or a theoretical investigation. Work is to be carried out over 2 sessions. At the end of the work a comprehensive project report giving an account of the student's own research must be submitted. Information on the preparation of project reports is contained in the University Calendar.

## **ELEC9772 Project Report B**

UOC6 HPW6

The project is done in a major area, in which it is offered under the supervision of an academic member of staff. Where the work is carried out externally a suitable co-supervisor may be required. Projects can take many forms such as the design and construction of experimental equipment or a theoretical investigation. Work is to be carried out over 2 sessions. At the end of the work a comprehensive project report giving an account of the student's own research must be submitted. Information on the preparation of project reports is contained in the University Calendar.

## **ELEC9971 Project Report A Extended**

UOC6 HPW6

The project is done in a major area, in which it is offered under the supervision of an academic member of staff. Where the work is carried out externally a suitable co-supervisor may be required. Projects can take many forms such as the design and construction of experimental equipment or a theoretical investigation. Work is to be carried out over 2 sessions. At the end of the work a comprehensive project report giving an account of the student's own research must be submitted. Information on the preparation of project reports is contained in the University Calendar.

## **ELEC9972 Project Report B Extended**

UOC6 HPW6

The project is done in a major area, in which it is offered under the supervision of an academic member of staff. Where the work is carried out externally a suitable co-supervisor may be required. Projects can take many forms such as the design and construction of experimental equipment or a theoretical investigation. Work is to be carried out over 2 sessions. At the end of the work a comprehensive project report giving an account of the student's own research must be submitted. Information on the preparation of project reports is contained in the University Calendar.

## Course Descriptions

### *Professional Development Courses*

#### **ELEC3104 Digital Signal Processing**

UOC6 HPW6

Processing and analysis of continuous (analogue) and discrete-time (digital) signals. Sampling continuous signals: the sampling theorem, reconstruction, aliasing and the z-transform. Analogue filters: Butterworth, Chebyshev, elliptic and Bessel filters. Filter impulse and frequency responses, stability and digital oscillators. The discrete Fourier transform (DFT) and the fast Fourier transform (FFT). Fundamentals of the design and realisation of finite impulse response (FIR) and infinite impulse response (IIR) digital filters. Linear and non-linear phase. Representation and modelling of non-deterministic signals, correlation functions, and power density spectra. Fixed-point filter implementation techniques and quantization noise effects.

#### **ELEC4601 Digital and Embedded Systems Design**

UOC6 HPW4

Topics include; introduction to custom digital processors including DSP hardware, high-speed digital design techniques, modern chip design methodologies, hardware and software co-design, advanced programming paradigms including state machines and concurrent processes, real-time programming and operating systems.

#### **ELEC4602 Microelectronic Design and Technology**

UOC6 HPW4

Basic IC processing technology: lithography, oxidation, diffusion, implantation, film deposition, etching, metalisation. IC technologies: Si, GaAs, SiGe, SOS, BiCMOS. Rev. MOS device models. On-chip components: capacitors, inductors, resistors, diodes. CMOS design rules, scaling. Floor planing, cell layout (inc. common centroid) and routing. Corner and Monte Carlo simulations. CMOS analogue building blocks: current mirrors, differential stage, active load. Noise sources and analysis. CMOS operational amplifiers. D/A converters and A/D converters. Oscillators, PLLs, Schmitt triggers and charge pumps. Static and dynamic CMOS gates and flip-flops. CMOS digital building blocks: level shifters, decoders, multiplexers, tri-states, buffers and adders. Memories: ROM, SRAM and DRAM cell design; Sense amplifiers. Introduction to MEMS. IO circuits, ESD, latch-up, assembly techniques and packaging. Interconnects and noise shielding; mixed analogue-digital design. Yield, reliability and failure analysis techniques; 6-sigma design.

#### **ELEC4612 Power System Analysis**

UOC6 HPW4

An overview of modern power systems. Review of the basic concepts used in power system analysis: phasors, complex power, three phase systems and per-unit methodology. Modelling circuit of power system components including transformers, generators, transmission lines and loads. Steady-state and dynamic behaviour of power systems. Network matrices and power flow analysis. Power system fault calculations: symmetrical components, symmetrical faults, unsymmetrical faults. Power system stability: swing equation, multi-machine applications. Power system protection principles. Power system control, economic dispatch. Distributed generation. Renewable energy generation systems. Electricity industry: recent changes in its structure and operating practices.

### **ELEC4613 Electrical Drive Systems**

UOC6 HPW4

Introduction to Electrical Drive Systems. Elements of Drive systems and their requirements for servo and industrial drive applications. Drive representation, quadrant operation, dynamic and regenerative braking. Transfer function representations of dc motor and converter and drive performance analysis. Performance analysis of induction motor drives with variable voltage, voltage source, current source and variable frequency supply. Performance analysis of synchronous and reluctance motors with variable frequency supply. Transducers in electric drive systems. The analysis of asymmetrically connected induction motors. Unified machine theory. Computer aided design and analysis.

### **ELEC4614 Power Electronics**

UOC6 HPW4

Power semiconductor switching devices and their limitations; Switching characteristics, protection and limitations of various types of power semiconductor switches; Elementary concepts in power electronics; Application of power electronic converters in energy conversion, utility applications and power supplies and utilizations; Diode rectifier circuits, multi-pulse rectifiers, input and output waveform characterization, filter design. Non isolated DC-DC converters, circuits topologies, characteristics with continuous and discontinuous conduction, circuit design and control considerations, Quadrant operation; Isolated DC-DC converters, transformer design issues, core resetting; Single-phase and three-phase DC-AC inverters, modulation strategies, output waveform analysis and filter design; Utility interfaces; High power applications; Converter system implementation.

### **ELEC4621 Advanced Digital Signal Processing**

UOC6 HPW4

FIR Lattice filters, All-pole IIR Lattice filters and their implementation; Fixed Point or finite word length implementations and effects; Random Processes, Auto-correlation, cross-correlation, and power spectrum estimation techniques; Least square filter design, Adaptive filters, Wiener filters, adaptive noise cancellation; Linear prediction, statistical and deterministic formulation. Applications of linear prediction. Time frequency analysis: short-time Fourier transform, quadrature mirror filter banks, multilevel filter banks and wavelet transform.

### **ELEC4622 Multimedia Signal Processing**

UOC6 HPW4

Signal acquisition, sampling and interpolation for signals in 1, 2 and 3 dimensions. Digital representation of multimedia signals, including representations for colour. Fourier transforms, power spectra and convolution in multiple dimensions. Introduction to shape, geometry and motion processing techniques. Compression technologies and standards for image, video, speech and audio signals. Communication technologies and standards for real-time multimedia signals, including protection. against and concealment of errors. Software and hardware techniques for representing and processing multimedia signals.

### **ELEC4631 Continuous-Time Control System Design**

UOC6 HPW4

Overview of systems and control with emphasis on modern and post-modern developments. Mathematical tools: matrix, quadratic forms and singular value decomposition (SVD). Modeling of multi-input multi-output (MIMO) systems by using state equations. Controllability and observability of MIMO systems. Linear quadratic regulator. Servo-regulator control. Lyapunov stability. State and output feedback control design. Robust control in state-space and optimisation based techniques.

### **ELEC4632 Computer Control Systems**

UOC6 HPW4

Examples of digital control systems, differences and similarities between digital and analog control systems, discrete-time systems, stability analysis, observability and Controllability, state space models, digital PID controllers, pole placement design, digital control systems characteristics, nonlinear discrete-time systems, optimal control design methods, discrete Kalman filter, identification, case studies.

### **ELEC4633 Real Time Engineering**

UOC6 HPW4

Real-time operating systems and processes: Concurrent processes. Multitasking and multithreading. Interrupts. Foreground/background systems. Context switching. Types of real-time kernels. Scheduling. Static and Dynamic scheduling. Rate-monotonic and Deadline-driven scheduling. Priority inversion, the priority inheritance and priority ceiling protocols. Markov Models. Inter-process communication and memory management: Data buffering. Shared memory. Global memory. Critical regions. Semaphores. Mutual exclusion. Message passing. Memory allocation. Coding practices. Real-time embedded system design: process specification. Q-models. State machines and systems of state machines. Date representation. Numerical issues. Assembly language and C. Input/output programming. Device drivers. The implications of using limited resources. Implementation: Microcontrollers. The Mitsubishi M16C/62 and Motorola MC68HC11 microcontrollers. RTLinux.

### **PHTN4661 Optical Circuits and Fibres**

UOC6 HPW4

Types and applications of optical fibres; ray analysis of multimode fibres; characteristics of single-mode fibres including experiments; losses and dispersion in fibres; fibre fabrication; cabling and handling fibres. Waveguiding in integrated optics & fibres; fabrication processes, optical substrates; modelling methods, manufacturing constraints on design; Photonic devices: Operating principles & applications of waveguide-based devices, selected from the following list: tapers, couplers, polarisers, Bragg gratings, filters, interferometers, fibre lasers & amplifiers; Operation & application of LEDs, lasers, & detectors.

### **PHTN4662 Photonic Networks**

UOC6 HPW4

All-optical & hybrid networks, topologies; WDM; optical switching & routing, SONET; dispersion management, BER & sources of noise, power budgets; phase modulation effects & nonlinear scattering in optical links; safety, regulations & standards.

### **TELE3118 Network Technologies**

UOC6 HPW5

Network architectures in terms of topology, role (client/server, peer-to-peer), and layered specification. Packet and circuit switching. Physical characteristics of network transmission links. Medium access control protocols for wired links (e.g. Ethernet) and wireless links (e.g. 802.11). Protocols for error and flow control and their link layer application. Interconnection of networks using bridges, switches and routers. Routing techniques, including Dijkstra's algorithm, distance vector and link state routing. Addressing and naming. Network congestion control. End-to-end protocols for matching applications to networks, including TCP and UDP. Network applications, such as web (HTTP), email (SMTP, POP, IMAP), and streaming media (e.g.VOIP).

## **TELE3119 Trusted Networks**

UOC6 HPW5

Authentication Protocols in Networks; Network Application Security (Email, VoIP), IP Security (IPsec), IP Address Spoofing, ARP Security; Securing Network Routing Protocols; Securing Network Transport Protocols; Security Specific Architectures/Protocols (TLS, SSL, Radius/Diameter, 802.11i), Network Firewalls; Network Management Security Issues (SNMPv3), Securing QoS in Networks, Principles of Public-Key and Symmetric Key Cryptography.

## **TELE4651 Wireless Communication Technologies**

UOC6 HPW5

Wireless communications channels: time-variant multipath fading, Doppler shift, fade rate, shadowing effect, time selective channel, frequency selective channel, the effects of fading on wireless transmission, performance analysis. Digital transmission over fading channels: continuous carrier-phase modulation, demodulations, performance analysis, burst-error correcting codes for fading channels, convolutional codes, soft output Viterbi algorithm, coded modulation, turbo principles, iterative processing, space diversity, time diversity and frequency diversity techniques. Wideband transmissions: spread-spectrum communications, DS-CDMA, frequency hopping, OFDM techniques, their applications.

## **TELE4652 Mobile and Satellite Communication Systems**

UOC6 HPW4

Introduction to Mobile Communications, Historical development of mobile telephony Mobile Communications Cellular Concept, Antennas and Antenna Arrays .Radio Propagation and Transmission Multi-path Signal Fading .Multiple Access Techniques .Modulation Techniques for Mobile Radio .Equalization and Diversity in Mobile Communications .Channel Coding for Mobile Communication Systems .Global System for Mobile – GSM (1) .Wireless Standards – GSM (2) .CDMA Spread Spectrum concept. IS-95 CDMA system implementation.

## **TELE4642 Network Performance**

UOC6 HPW4

Applications: (i) Services Required by Applications, (ii) Performance Requirements of Voice over IP, (iii) Performance Requirements Streaming Video, (iv) Performance Requirements Real Time Video. Capacity, Throughput and Service: (i) Source Traffic Characteristics, (ii) Statistical Multiplexing, (iii) Traffic Regulation, (iv) Bandwidth Utilization. Quality of Service (QoS) (i)Definitions of QoS, (ii)Best-Effort Service, (iii)Guaranteed QoS, (iv)Statistical QoS, (v)Delivering QoS via Admission Control. Traffic Models: (i)Stochastic Processes (ii)Discrete Time Markov Processes, (iii)Self-Similar Processes, (iv)Short and Long-Range Dependence. Queuing Theory: (i)Queuing System properties, (ii)Queuing Applied to IP Networks, (iii)Queuing Models, (iv)Scheduling Algorithms (v)The M/M/1 Queue (vi)The M/G/1 Queue (vii)The G/M/1 Queue (viii)Complex Queues, (ix)Effective Bandwidth, (x)Voice/Data Integration Savings. Network Design for QoS: (i)Putting it all Together, (ii)Designing a Network For End-To End Performance, (iii)Network Design Tools (iv)Network Scalability (v)Measuring Traffic and Performance.

## Appendix B

### *Research Areas of Academic Staff School of Electrical Engineering and Telecommunications*

#### **Energy Systems** (Head: Prof. Faz Rahman)

*A/Prof. Hugh Outhred*

*(Email: h.outhred@unsw.edu.au ) Room: 124 Electrical Engineering Building Telephone: 9385 4035*

Competitive electricity industry structure & regulation and related policy issues such as environmental sustainability; Grid-connected & stand-alone photovoltaic systems; wind energy; The interaction of distributed generation with electricity supply systems; Efficient electricity use.

*Dr. I. MacGill*

*(Email: i.macgill@unsw.edu.au) Room: 124B Electrical Engineering Building Telephone: 9385 4920*

Competitive electricity industry structure & regulation and related policy issues such as environmental sustainability; Grid-connected & stand-alone photovoltaic systems; wind energy; the interaction of distributed generation with electricity supply systems; efficient electricity use.

*Dr. Branislav Hredzak*

*(Email: b.hredzak@unsw.edu.au) Room: Electrical Engineering Building Telephone: 9385 4000*

Design and control of mechatronic systems and servo systems; Electric drives; Renewable energy; Electric and hybrid vehicles; Active balancing of rotating machinery

*Dr. Toan Phung*

*(Email: toan.phung@unsw.edu.au) Room: 107 Electrical Engineering Building Telephone: 9385 5407*

High-voltage engineering; Partial discharge measurement and analysis; Condition monitoring of power system equipment; Power system analysis.

*Prof. Faz Rahman*

*(Email: f.rahman@unsw.edu.au) Room: 133 Electrical Engineering Building Telephone: 9385 4893*

Servo motors and servo systems; Power electronic circuits for electrical drives; Drive analysis and design; Motion control systems design; Direct torque control; Rotor flux oriented vector control; On-line parameter and state estimation for drives; Power factor correction techniques/active filtering.

*Mr. Ted Spooner*

*(Email: e.spooner@unsw.edu.au) Room: 124 Electrical Engineering Building Telephone: 9385 4047*

Renewable energy power systems both stand alone and grid connected; Technical issues of grid connection of distributed generation; Power electronic applications for renewable energy systems.

#### **Microelectronics** (Head: Prof. Chee Yee Kwok)

*Prof. Andrew Dzurak*

*(Email: a.dzurak@unsw.edu.au) Room: W206G Newton Building Telephone: 9385 6311*

Development of enabling technologies for solid state quantum computation; Semiconductor nanostructures; single electron transistors; Quantum electronics including low-dimensional (1D and 0D) quantum devices; General solid state devices; Electron beam lithography.

*Prof. Chee Yee Kwok*

*(Email: c.kwok@unsw.edu.au) Room: 242 Electrical Engineering Building Telephone: 9385 5300*  
Microelectromechanical Systems (MEMS); Microactuators, microsensors, MOEMS; Optical cross-switches; Biomedical applications of MEMS; Microfabrication technology; Materials for MEMS; VLSI fabrication technology; Analog floating-gate CMOS design and devices; Low voltage low power designs.

*Dr. Torsten Lehmann*

*(Email: tlehmann@unsw.edu.au) Room: 208 Electrical Engineering Building Telephone: 9385 5374*  
Solid-state circuits and systems; Ultra low-power CMOS design; Bio-medical microelectronics; Cochlear implants; High-performance analogue circuits in deep sub-micron CMOS; VLSI neural networks.

*Dr. Andrea Morello (Email: a.morello@unsw.edu.au) Room: W201 Newton Building Telephone: 9385 4972*

Solid-state devices for quantum computing: manipulation and detection of single electron spins in silicon, single-electron transistors, quantum transport through individual dopant atoms; Quantum magnetism and molecular magnets; Low-dimensional superconductors, quantum phase transitions; Electron-, nuclear- and muon- spin resonance; Theory of decoherence and limits of quantum mechanics at the large scale; Magnetic probes at ultra-low temperatures.

*A/Prof. Rodica Ramer*

*(Email: ror@unsw.edu.au) Room: 305 Electrical Engineering Building Telephone: 9385 4759*  
Designing with ferrimagnetics; Designing with high temperature superconductors; Computer aided design (CAD); Nonlinear effects in optical fibres.

## ***Photonics (Head: A/Prof. Francois Ladouceur)***

*A/Prof. F. Ladouceur*

*(Email: f.ladouceur@unsw.edu.au) Room: 344B Electrical Engineering Building Telephone: 9385 5304*  
Integrated optics Modelling and optimisation of photonics devices ; hybrid integration ; photonics interconnects ; holography and interferometry.

*Prof. G.D. Peng*

*(Email: g.peng@unsw.edu.au) Room: 309 Electrical Engineering Building Telephone: 9385 4014*  
Optical fibre communication and fibre sensor systems; Application-specific glass optical fibres and devices; Application-specific polymer optical fibres and devices; Photonic signal processing technologies.

*Dr. Iain Skinner*

*(Email: i.skinner@unsw.edu.au) Room: 335 Electrical Engineering Building Telephone: 9385 5153*  
Optical fibres and integrated optics; Nonlinear optical switching; Optical solitons ; Nonlinear effects in optical fibres.

## ***Systems and Control (Head: Prof. Victor Solo)***

*Professor Branko Celler*

*(Email: b.celler@unsw.edu.au) Room: 461 Electrical Engineering Building Telephone: 9385 6546*  
Physiological systems modelling; Modelling of excitable tissues; Neural control of cardiac function; Neural control of renal function; Automated ECG signal processing and interpretation; Medical instrumentation; Medical information systems; Telemedicine remote monitoring.

*Dr. David Clements*

*(Email: d.clements@unsw.edu.au) Room: 205 Electrical Engineering Building Telephone: 9385 4015*  
Systems theory; Analysis of non-linear models for control; Numerical algorithms for control design; Control design-development of design techniques for robust control.

*Dr. Ray Eaton*

*(Email: r.eaton@unsw.edu.au) Room: 207 Electrical Engineering Building Telephone: 9385 4059*  
Control of large-scale systems; Analysis and control of non-linear systems; Backstepping; Sliding-mode control; Control of output-feedback systems.

*A/Prof. Tim Hesketh*

*(Email: t.hesketh@unsw.edu.au) Room: G8 Electrical Engineering Building Telephone: 9385 4009*  
Computer aided design and real-time control; Control algorithms; Control applications.

*A/Prof. Tuan Duong Hoang*

*(Email: h.d.tuan@unsw.edu.au) Room: 206 Electrical Engineering Building Telephone: 9385 5375*  
Systems Engineering (uncertain linear and nonlinear systems, linear and nonlinear robust control and filtering, adaptive control, fuzzy logic control with applications in vehicle control, aeronautics and robotics); Digital Signal Processing (digital filter and filter bank design, multi-dimensional filters and applications in image processing, digital communication); Broadband communication (trans-multiplexer for multi-carrier data transmission, multi-input multi-output (MIMO) and diversity techniques, space-time coding, multiuser detection, channel estimation and equalization); Optimization (convex programming, global optimization with engineering applications); Mobile computing

*Professor Andrey Savkin*

*(Email: a.savkin@unsw.edu.au) Room: 203 Electrical Engineering Building Telephone: 9385 6359*  
Robust and nonlinear control; Hybrid dynamical systems; Control of communication networks; Application of control and signal processing to Biomedicine; Missile guidance.

*Professor Victor Solo*

*(Email: v.solo@unsw.edu.au) Room: 237 Electrical Engineering Building Telephone: 9385 4010*  
Stochastic control, adaptive control; Adaptive signal processing in Telecommunications; Signal processing; Medical image processing; System identification; Time series analysis.

## **Signal Processing (Head: Prof. David Taubman)**

*Dr. Elias Aboutanios*

*(elias@unsw.edu.au) Room: 308 Electrical Engineering Building Telephone: 9385 5010*  
Signal and image processing; Radar and sonar signal processing; Statistical and multidimensional signal processing; Parameter estimation; Signal detection.

*Prof. E. Ambikairajah*

*(Email: e.ambikairajah@unsw.edu.au) Room: G6 Electrical Engineering Building Telephone: 9385 4000*  
Speech processing: speech speaker recognition; Speech recognition; Speech coding and enhancement; Neural networks and pattern recognition; Cochlear modelling; Engineering education.

*Dr. Julien Epps (Email: j.epps@unsw.edu.au) Room: 337 Electrical Engineering Building Tel: 9385 6579*

Speech modeling and front-end processing; Speaker verification, speech recognition, speech and audio coding, auditory modelling, speech enhancement; Genomic signal processing; DNA sequence analysis, microarray analysis; Applications of digital signal processing and pattern recognition.

*Dr. Deep Sen*

*(Email: dsen@ee.unsw.edu.au) Room: 306 Electrical Engineering Building Telephone: 9385 4754*

Digital signal processing; Biophysical modelling of auditory physiology; Speech and audio processing; Speech compression, enhancement, recognition; Audio compression; Text to speech synthesis.

*Prof. David Taubman*

*(Email: d.taubman@unsw.edu.au) Room: 303 Electrical Engineering Building Telephone: 9385 5223*

Image and video compression; Image & video enhancement; Statistical methods for image reconstruction & Restoration; Distributed multi-media processing systems; Image video analysis.

## **Telecommunications (Head: Prof. David Taubman)**

*A/Prof. Robert Malaney*

*(Email: r.malaney@unsw.edu.au) Room: 326 Electrical Engineering Building Telephone: 9385 6580*

Quality of service in data networks; Network management; Wireless communications; Positioning systems.

*Dr. Tim Moors*

*(Email: t.moors@unsw.edu.au) Room: 341 Electrical Engineering Building Telephone: 9385 4885*

Transport protocols/TCP; Dependable networks; Quality of service over wireless LANs; Protocol architectures; Computer communications; Networks, internet, data networking; Local area networks; Wireless and mobile networks.

*Professor Aruna Seneviratne*

*(Email: a.seneviratne@unsw.edu.au) Room: 316 Electrical Engineering Building Telephone: 9385 5389*

QOS management; IP protocols and mobility; Programable networks; Internet service architectures.

*A/Prof. Jinhong Yuan*

*(Email: j.yuan@unsw.edu.au) Room: 324B Electrical Engineering Building Telephone: 9385 4244*

Mobile & satellite communications; Communication system evaluation; Digital modulation; Information theory; Error control coding; Channel modelling; Antenna array; Joint source & channel coding; Turbo coding and interactive processing; Space-time coding and processing; Wideband-CDMA and OFDM wireless systems.

*Dr. Wei Zhang*

*(Email: w.zhang@unsw.edu.au) Room: 325 Electrical Engineering Building Telephone: 9385 4033*

Mobile and wireless communications; space-time coding and MIMO; cooperative communications; cognitive radio; ultra-wide band communications.