Electronic Engineering

Course Description

(Unless otherwise specified, all are 3-unit term courses of three hours of lecture and one hour of tutorial per week.)

ELE1110
Basic Circuit Theory
Basic circuit theorems; mesh and nodal analysis; modified nodal analysis; State Equations. Topological formulation of circuit equations. Transient and steady-state analyses. AC circuits. Frequency responses. P-N junction diode; bipolar and unipolar transistors; diode and transistor models; large signal and small signal analyses; operation amplifiers.

ELE2110
Electronic Circuits
Bipolar and FET amplifiers. Differential amplifiers. Operational amplifiers and applications. Frequency response of amplifiers. Feedback principles. Oscillators, multivibrators and wave generators. Logic circuits: ECL and CMOS. Students are advised to take ELE1110 before taking this course.

ELE2120
Digital Circuits and Systems
Digital circuit technologies of logic families, circuit characteristics: noise immunity, loading effect, fan-in and fan-out, logic timing analysis. Analysis of TTL switching circuits. Combinational logic design techniques: Boolean algebra, K-map and Quine-McCluskey. Functional blocks of combinational logic. Sequential logic circuits. Synchronous and asynchronous sequential machine design procedures. Digital systems design. (Not for students who have taken ERG2020.)

ELE2210
Electrical Technology
Electromagnetism and magnetic circuits. Single-, two- and three-phase circuits. Direct-current machines. Transformers. AC synchronous machines. Three-phase induction motors. Stepper motors. Two-phase servomotors and single phase induction motors. Power electronics. Electrical Measurements.

*ELE2230
Computer-aided Electronic System Design

ELE2240
Control and Electrical Technology
Linear approximation of engineering systems. Transfer function and block diagrams. Transient response and steady state errors. Characteristic equation. Stability analysis. Root locus. Controllers and compensators. Magnetic circuits and transformers. Three phase circuits and power systems. Alternators and induction motors. Direct current generators and motors. Feedback control systems with synchros and direct current motor actuators. Students are advised to take ERG2030 before taking this course. (Not for students who have taken ACE2030.)

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* *Course offered in 1999-2003.*

ELE2510
Microelectronic Devices
Fundamentals: atoms, bonds, crystal structures, electrons in solids, band structure, effective mass and the Fermi Energy. Conduction in semiconductors: intrinsic, extrinsic, drift, mobility, diffusion, recombination, Hall effect. Junctions: metal/semiconductor, p/n, breakdown, MOS diode. Transistors: MOST, JFET, MESFET, BJT. I.C. fabrication: layout, lithography, layer formation.

ELE2860
Professional Engineering Practice
2 U; 2 Lect.; 1-2 Tut
Introduction to engineering: engineering practice; professional ethics; professional societies. Industrial environment: health and safety; the trend of global and local industries. Engineering management: project management; quality assurance; communication skills and personal developement.

ELE3010
Introduction to Lasers and Photonics
This course is intended for undergraduate engineering and science students. It covers the basic physics, engineering and system aspects of various lasers and a broad range of photonic technologies. This course then addresses their important roles in modern information systems. The course contents include the basic principles and the engineering applications of lasers and photonics, using real-life examples from a wide-range of photonics information systems including state-of-the-art optical display, optical storage, optical communications and optical sensors.

ELE3210
Analog Integrated Circuits
Ideal and non-ideal op-amp characteristics. SPICE models and simulations. Complete DC, small signal analysis of a 741 type op-amp including internal design. Noise consideration. Applications and design techniques: current and voltage sources, current to voltage and voltage to current converters, regulator, band-gap reference, switching regulator, active rectifier, logarithmic amplifiers, Gilbert multiplier, phase detector, active filters, digital to analog and analog to digital converters, temperature compensation. Basic phase lock loop theory and applications. Students are advised to take ELE2110 before taking this course.

ELE3230
Microprocessors and Computer Systems
CPU registers and control units, Addressing modes and instruction set. Bus and data path. Memory systems. Input/output techniques: programmed I/O, interrupt and DMA. Assembly language and programming techniques. Computer/microprocessor applications. Case study of a computer/microprocessor system. Students are advised to take ELE2120 or ERG2020 before taking this course.

ELE3240
Medical Instrumentation and Sensors
Foundamental concepts of the design of instrumentation and sensor. Electrode theory. Wireless electrodes. Transducers. Biosensors. Applications of microprocessor system for measurements. Micro-controllor based measurement systems. The origins and measurements of bioelectric, ultrasonic and bioaccoustic signals. Applications: electro-bioimpedance measurements, cochlear implant devices and transdermal drug delivery systems; and distributed random Functional Electric Stimulator. Electrical safety and hazard.

ELE3310
Basic Electromagnetic Theory
Review of vector analysis and differential equations. Stationary fields. Maxwell's equations and time-varying fields. Scalar and vector potential. Wave equations and solutions. Plane waves. Transmission lines and waveguides. Microstrip lines and passive circuits. Numerical methods in electromagnetics. Students are advised to take ERG2011 before taking this course.

ELE3320
Introduction to Optical Communications
Comparison between optical and non-optical (such as copper-based and microwave) communications. Theory of dielectric optical waveguides. Single-mode and multi-mode optical fibres. Propagation of optical waves in fibres. Fibre parameters and measurement techniques. Manufacturing and splicing of fibres. Fibre components for communication systems. LED and laser diode sources. Detection and amplification of optical signals. Techniques for optical signal enhancement. Multiplexing techniques. Analog and digital optical transmission systems. Students are advised to take ELE2510 and 3310 before taking this course.

ELE3330
Wireless Transmission Systems
Common wireless systems and international communication standards. Antenna fundamentals. Antenna arrays. Applications: mobile phone handset, basestation and trunk antennas. Antenna measurement techniques. Propagation basics. UHF and microwave line-of-sight links. Propagation over suburbs, urban areas, into and inside buildings. Multipath fading models. Wideband channel characterization. Propagation measurement techniques. Introduction to radar system and satellite communication system. Students are advised to take ELE3310 before taking this course.

ELE3340
Analog and Digital Communications
Orthogonality and signal representations. Design and analysis of amplitude, phase, and frequency modulation systems. Digital modulation systems, optimum binary receiver and the matched filter, coherent and non-coherent reception of ASK, FSK, PSK, DPSK, M-ary communications. Introduction to information and coding theory. Students are advised to take ELE3410 before taking this course.

ELE3410
Random Processes and Digital Signal Processing
Random variables and random processes. Gaussian processes. Correlation functions and power spectral density. DTFT and DFT. Z-transform and inverse Z-transform. Frequency response and stability of DT systems. Student are advised to take ERG2030 before taking this course.

ELE3510
Solid State Electronics
Introduction to quantum mechanics: particle-wave nature of electron, Schrodinger equations, electrons in 1-D potential well and potential barrier. Hydrogen atom and the periodic table. Properties of bonds. Concepts of band theory of solids. Free electron model of metals. Case studies of electronic properties of materials: e.g. semiconductors, dielectric and magnetic materials, superconductors, optoelectronic materials, and some other advanced applications. Students are advised to take ELE2510 before taking this course. (Not for students who have taken ELE4570.)

ELE3520
Computer-Aided Circuit Analysis and Hardware Description Languages
This course is characterized by its requirement on students to learn electronic design tools through practical exercises. Circuit Level - SPICE as a hardware language, circuit analysis using PSPICE, PSPICE analog behavioural models and model parameters. Logic Level - Electronic design domains, hardware description languages, AHPL, VHDL and Verilog. System Level - Introduction to SpecC. Engineering drawings, introduction to computer graphics. Students are advised to take ELE2110 and 2120 before taking this course. (Not for students who have taken ELE2230.)

ELE3820
Electronic Engineering Laboratory
1 U; 4 Lab.

ELE4110
Bioelectronics
Electrical safety and hazard. Interference and shielding. Nature, measurement and special considerations of bioelectrical signals in general. Generation, propagation and measurement of biopotentials: ECG, EEG, EMG, EGG, ERG, etc. Nature and application of bio-impedance. Bio-instrumentation techniques and special considerations. Topics in bio-electronics of recent interest.

ELE4120
Bioinformatics
Basic concepts of bioinformatics engineering; database basics, text, visual and multimedia data representation, acquisition and presentation; computational and statistical methods in biological systems; signal processing and knowledge engineering in DNA sequence analysis; introduction to genetic engineering.

ELE4190
Biomedical Modelling
Basic physiologic systems: neuromuscular system, auditory system, pulmonary-cardiovascular system etc. Renewal process. Bioelectric phenomena: action potentials, cellular membrane models, volume conductor models, ECG, EMG, EEG, etc. Biomedical modelling: lumped element model, bioimpedance, medical ultrasound, dispersion effects, and otoacoustic emissions. Topics in biomodelling of recent interest. Prerequisite: ELE3410.

ELE4210
Network Synthesis
Basic network theories. Analysis and synthesis of passive and active networks. Analog filter design. Approximation and optimization methods. Analysis and design of switched-capacitor filters. CAD for filter design. Recent trend.

ELE4220
Multiprocessor System, Implementation and Applications
Introduction and classification of parallel and multiprocessing. Multiprocessor architecture, analytical modelling, operational analysis, simulation and bench-marking. Applications: transputer system, fault-tolerant system, image and signal processing system. Prerequisite: ELE3230 or its equivalent.

ELE4230
Microprocessor Design and Organization
Advanced topics in microprocessors. Microprocessor design: CISC and RISC, processor design, control design. System organization. Memory organization: virtual memory and cache. Parallel computer architectures. Associative processors and memories.

ELE4310
Modern Communication Systems
Communication fundamentals: signals, coding and error control, antennas and propagation, communication networks and TCP/IP protocols.Wireless Systems: spread spectrum systems, satellite communications, cellular networks, wireless LAN, Bluetooth. Broadband communications: optical fiber systems, cable modem and ADSL access.(Include one communication system simulation project). (Not for students who have taken IEG4100.)

ELE4320
Microwave Electronics
Revision of transmission line theory, Smith chart and principles of impedance matching. Microstrip lines. S-parameters. Microwave network analysis. High frequency electrical characteristics of microwave components. Noise analysis. Microwave circuit design principles, CAD tools and fabrication. Microwave measurement techniques.

ELE4410
Advanced Digital Signal Processing and Applications
Design and realization of digital filters. Optimal statistical filtering. Adaptive filtering. FFT and Time-frequency analysis. Spectral estimation. Application examples of OSP. Students are advised to take ELE3410 before taking this course.

ELE4430
Digital Image Processing
Acquisition and representation: 2D and 3D imaging, visual perception, sampling and digitization. Pre-processing: imaging geometry, radiometric and geometric corrections. Processing: transformations and filtering, enhancement, codings, and restoration. Analysis: segmentation, descriptions and recognition. Introduction to pattern recognition. Image processor and systems. Real time image processing. Selected topics in image motion, image morphology, multiscale image analysis and higher dimensional object modelling. (Not for students who have taken IEG4160.)

ELE4510
Physics and Technology of Semiconductor Devices
Review of semiconductor physics. Advanced MOS devices. Special microwave devices: tunnel devices, transfer electron devices, etc. Photonic devices: LED, semiconductor lasers, photodetectors, solar cells. Semiconductor sensors and transducers. Introduction to materials and technology for advanced semiconductor devices. Heterojunction concepts and devices: HEMT, HBT, quantum-well devices. Introductory optoelectronic integrated circuits.

ELE4520
Integrated Optics
An introduction to integrated optics and its applications in communications systems. Optical waveguide modes and parameters. Waveguide fabrication techniques. Coupling techniques and losses in optical waveguides. Waveguide couplers, modulators and switches. Electro-optic, magneto-optic and acousto-optic effects. Characteristics and modulation of semiconductor lasers. Distributed feedback and distributed Bragg reflector lasers. Integrated optical detectors. Current trends and fundamental limits of integrated optics. Students are advised to take ELE3320 before taking this course.

ELE4530
Integrated Circuits Fabrication Technology
Modern IC fabrication of CMOS and bipolar transistors. Simple geometric layout of integrated circuits. Process engineering for VLSI fabrication: photolithography, plasma etching, ion implantation, chemical vapour deposition, epitaxy, oxidation, diffusion and metallization. Process simulations. Reliability, yield and packaging of IC's.

ELE4540
VLSI Testing and Testability Design
Difficulties and problems of conventional methods for testing LSI/VLSI circuitry. Design for testability: basic concepts and approaches. Software and equipment supports. Analyses of testability-design approaches and potentials. Discussion of test-related questions and future possible developments.

ELE4550
Application Specific IC Technologies
Circuit techniques: bipolar, CMOS. ASIC Design Styles: PLD, gate Array, standard cell, silicon compiler, selection criteria. ASIC design automation: VHDL, EDIF, synthesis, schematic capture, simulation, placement, routing. Testability considerations: testability evaluation, test vector generation, fault simulation, structured design for testability, ATE.

ELE4560
Electronic Thin Film Science
Thin film deposition and layered structures. Surface energies. Diffusion in solids. Stress in thin films. Surface kinetic processes. Homoepitaxy: Si and GaAs. Heteroepitaxy and superlattices. Electrical and optical properties of heterostructures, quantum wells, and superlattices. Schottky barriers and interface potentials. Solid phase amorphization, crystallization and epitaxy. Interdiffusion. Thin film reactions. Grain boundary diffusion. Electromigration in metals.

*ELE4570
Solid State Electronics

ELE5140
Biomedical Information Engineering
Neuro-informatics: neural communication, neuro-myoelectrical channel, random point process, biomodulation, cable analogy, biotissue and dispersion filtering, biodemodulation. Medical information technology: HIS, virtual hospital, wireless physiologic sensing, medical data compression and telemedicine techniques. Selected topics of recent interest.

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* *Course offered in 2000-03.*

ELE5210
CMOS Analog Integrated Circuits
Review MOS device properties and electrical models. Basic analog circuit building blocks including simple and cascode current sources, active loads, common source and common drain amplifiers, DC biasing networks, and differential amplifiers. Analog sub-systems building blocks including CMOS OTA op-amp, OCA, comparators, A/D, D/A, and switching capacitor circuits. Selected topics in CMOS RF circuits.

ELE5260
CMOS Integrated Circuits
Modern circuit design techniques used in current CMOS integrated circuits. CMOS digital and analog integrated circuits: static and dynamic logic, transmission gate intensive logic, switching characteristic of static logic, I/O buffer, CMOS, SRAM and operational amplifier.

ELE5270
Computer-Aided Circuit Analysis
Formulation of circuit equations. LU decomposition and sparse-matrix solutions. Numerical integration and recursive convolution integration. Generalized characteristic model analysis and synthesis of distributed-lumped networks. Dynamic device modelling and simulation. Case studies.

ELE5350
Advanced Electromagnetism
Review of electromagnetics fundamentals. Green's Function: scalar, vector and dyadic forms. Electromagnetic sources: point source, line source, sheet source and ring source. Plane wave, cylindrical wave and spherical wave. Electromagnetic theorems and principles: duality, uniqueness, reciprocity, surface and volume equivalence, etc. Transmission in waveguide and layered material. Scattering from canonical structures. Analytical and numerical solutions of Maxwell's Equation: asymptotic method, finite element method, etc.

ELE5370
Introduction to Radar
Fundamentals of radar system, radar functions and radar equation. Various types of radar. Monostatic and bistatic radar. Continuous Wave (CW) radar, Doppler radar. MTI radar. Frequency modulated radar (Chrlp radar). Pulse radar. Pulse Doppler radar. Monopulse radar. Ambiguity regions, clutter, meteorological radar. Examples: vehicular collision avoidance radar, cross harbour electronic toll system, doppler radar for vehicular velocity monitoring, wind shear radar at airport, terminal doppler weather radar (TDWR) on airport runway, harbour surveillance radar, etc.

ELE5380
RF Integrated Circuits and Systems
Introduction to radio communication systems; wireless standards; transceiver architectures; characteristics of passive IC components; review of semiconductor devices: bipolar, CMOS, MESFET; design examples: LNA, mixer, RF power amplifier, phase-locked loop, oscillator and synthesizer, applications: GSM and DECT system. Prerequisite: ELE4320.

Study Scheme

1. Major Programme

Students are required to complete a minimum of 79 units of Major courses as follows:

(i) Required Courses: 55 units
ERG1810, 2011, 2012, 2030, 2310, 2810, 3810#, 3820#, 4910#, 4920#, ELE1110, 2110, 2120, 2510, 2860, 3210, 3230, 3310, 3820, CSC1110, ELT1111
Graduation Project as prescribed by ERG4920 will carry a separate weight of 6.79% in honours classification.

(ii) Elective Courses: 24 units
Group A: select any three courses with at least two courses coded 3000:
ELE2230, 2240, 3010, 3240, 3320, 3330, 3340, 3410, 3510, 3520, CSC2100, IEG3310#, SEG2440
Group B: select any five courses:
ELE4120, 4190, 4230, 4310, 4320, 4410, 4430, 4510, 4520, 4530, 4550, 4560, 4570, 5140, 5210, 5260, 5270, 5350, 5380, IEG4100#, MSE4210#

Total: 79 units

Recommended course pattern

Term 1	**Units**	**Term 2**	**Units**	**Term 3[3]**	**Units**
CSC1110	3	ELE2110	3	ELE2510	3
ELE1110	3	ELE2120	3	ELE3230	3
ELT1111	3	ERG2012	3	ELE3310	3
ERG1810	1	ERG2030	3	ERG3810	1
ERG2011	3	ERG2310/Elective[2]	3	Group A Elective	3
Physical Education	1	ERG2810	1	General Education/	3
General Education/	3	Physical Education	1	Free Elective[1]	
Free Elective[1]					
	—		—		—
	17		17		16
Term 4[3]	**Units**	**Term 5**	**Units**	**Term 6**	**Units**
ELE2860	2	ERG4910	4	ERG4920	4
ELE3210	3	Group B Electives	9	Group B Electives	6
ELE3820	1	General Education/	3	Group A Elective	3
ERG3820	2	Free Elective[1]		General Education/	3
Group A Elective	3			Free Elective[1]	
General Education/	6				
Free Electives[1]					
	—		—		—
	17		16		16

Notes: [1] 12 units of them must be General Education courses, the rest are free electives. Students are recommended to take some management and/or business administration courses to satisfy the professional requirements.

[2] If students wish to take four 3-unit Major courses in Term 2, they can take ERG2310 in the second year of attendance.

[3] Students who have not taken ERG2310 in Term 2 should take it in their second year of attendance.

SUMMARY

	Units
General Education	12
Physical Education	2
Major Required Courses	55
Major Electives	24
Free Electives	6
Total	99

Notes: 1. Major courses coded 3000 and above will be included in the calculation of the Major GPA for honours classification. Courses with " # " are to be included in the Major GPA as well.

2. Besides the Major courses mentioned in Note 1, the other ELE courses coded 3000 and above taken by the students will also be included in the calculation of Major GPA.

2. Minor Programme

Students are required to complete a minimum of 18 units of Major courses:

(i)	Required Courses: ELE1110, ERG2020	6 units
(ii)	Elective Courses (at least 6 units at 3000 level or above): ERG2030, 2310, ELE2110, 2230, 2510, 3010, 3210, 3230, 3240, 3310, 3320, 3330, 3340, 3410, 3510, 3520, 4120, 4190, 4230, 4310, 4320, 4410, 4430, 4510, 4520, 4530, 4550, 4560, 4570, 5260, 5380	12 units
	Total:	18 units

Notes: 1. A maximum of 6 units course exemption will be considered.

2. A maximum of 6 units can be used to fulfil both the Major and Minor programme requirements.

3. In any case, the total number of units exempted and used to fulfil both the Major and Minor programme requirements cannot exceed 6 units.

4. Major students minoring in Electronic Engineering are required to declare which ELE coded courses will be counted towards the fulfilment of the requirements of the Minor programme in Electronic Engineering at their final term of attendance.

3. Faculty Language Requirement

(Please refer to the "Faculty Language Requirement" of Faculty of Engineering for details.)

4. Major/Faculty Requirement for S6 Entrants

(Please refer to the "Major/Faculty Requirement for S6 Entrants" of Faculty of Engineering for details.)