



Masters or Doctor of Engineering



Postgraduate Coursework Programmes

- *Information and Communications Technology*
- *Microelectronics*
- ***Power Systems***





Power Systems

(ME(PSE))

The field of Power Systems Engineering (PSE) encompasses a wide range of areas in which power systems planning and design, management, operation, control and protection are the key ones. Modern power technologies draw on the recent developments in power electronics, computer, control and communications engineering. The Master of Engineering (ME) course in the field of power systems offered by The School of Electrical, Electronic and Computer Engineering at The University of Western Australia has a focus on the key areas in this field in the context of modern power systems.

The ME (PSE) course duration is 2 years (96 points). The course includes preparatory units of up to 48 points with the objective of reviewing and reinforcing the candidate's knowledge in the field of power systems and supporting areas. The preparatory units will be determined by The School on the basis of the candidate's background and experience. For applicants with advanced standing in the field of power systems, credit for up to 48 points may be granted to allow direct entry into the advanced programme at ME level.

The advanced programme comprise:

four 6-point units to be selected from the following:

- Transmission System Design, Control and Operation ELEC8340
- Energy Management System ELEC8341
- HVDC & FACTS ELEC8342

- Numeric Protection, Communications and Transducers ELEC8343
- Power Quality and Corona Noise ELEC8344
- Power Systems Control ELEC8345
- Power Systems Modelling ELEC8346

plus units to the value of at least 6 points from the above list or from other ME programmes offered by UWA subject to prerequisites.

plus a substantial 18-point individual research project in the field of power systems:

- Dissertation ME(PSE) ELEC8347, ELEC8348 and ELEC8349

The likely employment opportunities for graduates of this programme are in the power industry in Australia and overseas, including power companies/utilities, consulting firms, mining and resources sectors.

Lecturers and project supervisors in the programme are drawn from the School of Electrical, Electronic and Computer Engineering, and from power industry in Western Australia.

Enquiries for enrolment may be directed to:

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ELEC8340 - Transmission System Design, Control and Operation

Credit: 6 points

Availability: Semester 2

Outcomes: Students develop knowledge and understanding of key issues in the design, control and operation of a transmission system in relation to its protection and load-frequency control in the power market. Within the unit, the topic of alternative energy technologies helps students understand some aspects of sustainable development and the need for renewable energy sources in electricity generation together with their integration into power systems.

Content: This unit covers the following:

1. Lightning phenomena; electrogeometric models (EGMs) of lightning; applications of EGMs in optimal shielding designs for substations and overhead power transmission lines; and evaluation of the lightning performance of shielding systems by Monte Carlo method.
2. Asymmetrical short-circuit fault analysis and applications in power systems. Power systems protection— protection functions; fault clearing-time requirements; power system transient stability and critical fault-clearing time; real-time monitoring for protection purposes; digital systems of protection; protection zones; multi-zone distance-to-fault measuring systems; polar characteristics; response time characteristics; differential protection; overcurrent protection.

Economic dispatch and load-frequency control in power market; alternative energy technologies— integrating renewable energy sources into power systems; photovoltaics; wind generators; and fuel cells.

Assessment: This includes an examination and/or assignments/projects. They assess the student's understanding of the key issues included in the design, control and operation of a transmission system. The assignment in the second part of the unit assesses students' understanding of the need for sustainable development and for new and renewable energy technologies, and from it the global and environmental responsibilities of the professional engineer. It also assesses students' ability to communicate effectively in a written form.

Prerequisites: ELEC2302

Electromagnetics and Electromechanics or equivalent

Advisable prior study: assumed prior knowledge in power systems [at a level equivalent to ELEC3305 Power and Machines (formerly 620.332 Power and Machines 332/ ENGT3305 Power and Machines) and Part 1 of ELEC4340 Power Transmission and Filtering (formerly 620.457 Power Transmission and Control 457/ENGT4307 Power Transmission and Control and 620.448 Optimum and Adaptive Filtering 448/ENGT4305 Optimum and Adaptive Filtering)]

Contact hours: 60 (lectures: 36 hrs; tutorials: 12 hrs; project: 12 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8340>

ELEC8341 - Energy Management System

Credit: 6 points

Availability: Semester 1

Outcomes: Students develop an in-depth understanding of the main functions of the energy management system (EMS). In particular, they develop an understanding of OPF formulation with security constraints together with solution methodology based on constrained optimisation.

Content: This unit covers optimal operating states; automatic control and monitoring measures; SCADA system and its functions; load forecasting; state estimation; generator unit commitment; load dispatching; automatic generation control; optimal power flow; static and dynamic security assessments; load shedding; alarm processing; maintenance scheduling; cost accounting; computer resource requirements; objective functions; generation cost minimisation; network active-power loss minimisation; control variables; network operating constraints; comparisons among different formulations; security-constrained optimal power flow; inclusion of post-contingency corrective rescheduling; minimisation of control shift in rescheduling; minimising operating constraint violations; constrained optimisation methods.

Assessment: This includes an examination and/or assignments/projects. The examination assesses the students' in-depth understanding of the

materials presented and discussed in the lectures and tutorials. The assignments/projects test their ability in designing and implementing in software the key formulations related to OPF with security constraints.

Advisable prior study: assumed prior knowledge in power systems [at a level equivalent to ELEC3305 Power and Machines and ELEC4307 Power Transmission and Control]

Contact hours: 52 (lectures: 26 hrs; tutorials: 11 hrs; project: 15 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8341>

ELEC8342 - HVDC and FACTS

Credit: 6 points

Availability: Semester 2

Outcomes: Students develop an in-depth understanding of the theory and applications in power systems of High Voltage Direct Current (HVDC) transmission and Flexible AC Transmission Systems (FACTS) devices, including static VAR compensators (SVC) and Static Synchronous Compensators (STATCOM) based on thyristors, GTO thyristors and IGBTs.

Content: This unit comprises the following topics: (1) HVDC—conversion and inversion principles; converter and inverter configurations, rectifier operation; inverter operation; converter harmonics, harmonic elimination; high-pulse order configuration; harmonic

filtering; analogue and digital control of converter and inverter; control strategies; individual phase control; equidistant firing control scheme; phase-locked oscillators; constant current control, inverter excitation angle control; control stability; interactions between AC and DC systems; computer simulation of HVDC interconnections; dynamic response evaluations; protection; HVDC transmission with voltage-source converters (VSCs) based on gate-turn-off (GTO) thyristors and insulated gate bipolar transistors (IGBTs); (2) Flexible AC Transmission Systems (FACTS) including thyristor-based reactive-power Static VAR Compensators (SVC), series compensation, inverter based Static Synchronous Compensators (STATCOM), Unified Power Flow Controllers (UPFC) and other devices; compensator control strategies; choice of control signals; and compensator characteristics.

Assessment: This may include examinations and project assignments. The examination assesses the students' in-depth understanding of the materials presented and discussed in the lectures and tutorials. The project assignments test students' competence in designing systems of which HVDC links and/or FACTS devices are a part.

Advisable prior study: assumed prior knowledge in power systems [at a level equivalent to ELEC3305 Power and Machines and ELEC4307 Power Transmission and Control]

Contact hours: 42 (lectures: 24 hrs; tutorials: 12 hrs; project: 6 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8342>

ELEC8343 - Numeric Protection, Communications and Transducers

Credit: 6 points

Availability: Semester 1

Outcomes: Students develop an in-depth understanding in the area of power systems protection. They achieve a thorough knowledge and technical competence in a wide range of numeric protection systems together with the communications and transducers that support the operation of the protection system.

Content: This unit comprises the following topics: (1) numeric protection—numeric distance protection; elements of signal processing involved; direct online evaluation of impedances using Fourier transform, curve fitting and Kalman filtering; differential equation method based on primary system model; steady-state and dynamic response evaluations; digital current differential protection for transmission circuits; synchronous and non-synchronous data sampling; time alignment of data; numeric evaluation of protection operating and bias signals; digital transformer differential protection; digital techniques for harmonic biasing; digital overcurrent protection; numerical low-impedance busbar protection; (2) communications

in power networks—requirements in terms of telemetering, data, control signal and voice communications; transmission media; communication links based on the conductor systems of power lines; microwave; optical fibre; (3) transducers—electromagnetic transducers; wound voltage transformers; capacitor-voltage transformers; current transformers; transducer modelling; frequency and transient response evaluations; and (4) optical current transformer operating principles; fibre optical links; digital outputs; steady-state and dynamic performance requirements; and optical voltage transducers based on electro-optical effect.

Assessment: This includes an examination and/or assignments/projects. The examination assesses the students' in-depth understanding of the subject matter presented and discussed in the lectures and tutorials. The assignments/projects test their ability in applying the theory and materials to solve practical problems related to power systems protection.

Advisable prior study: assumed prior knowledge in power systems [at a level equivalent to ELEC3305 Power and Machines and ELEC4307 Power Transmission and Control]

Contact hours: 52 (lectures: 26 hrs; tutorials: 11 hrs; project: 15 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8343>

ELEC8344 - Power Quality and Corona Noise

Credit: 6 points

Availability: Semester 1

Outcomes: Students develop an in-depth understanding and technical competence in power quality assessment and harmonic analysis in power systems and evaluating the performance of power transmission lines in terms of their corona power losses and noise.

Content: This unit comprises the following topics: (1) power quality—indices of quality of supply; voltage magnitude variations; system frequency errors; operating imbalances; quantifying waveform distortions; harmonic distortion; sources of harmonics; adverse consequences of harmonics; harmonic measurements; transducers for harmonic measurements; locating harmonic sources by measurements; harmonic analysis methods; parametric techniques; statistical approach to harmonic analysis; network models for harmonic analysis; harmonic resonances; harmonic filtering; optimal harmonic filter design; and (2) corona—corona noise; conductor surface states and weather conditions; evaluation of noise-levels; noise data recordings; signal-to-noise ratio and the quality of reception; television interference; noise measurement principles; radio-noise meters; bandwidth; ANSI and CISPR standards; frequency spectrum of noise; discharge pulse waveshape; the

excitation function in power spectral-density form; radiated noise fields; lateral profiles and frequency spectra; computer-based evaluation procedures; principal design options; radiated noise fields; comparison of noise field levels for different design options; evaluation of active-power loss due to corona; non-linear voltage-charge characteristics; dependences of corona loss on weather condition, conductor surface condition and surface gradient; separation into reduced loss and reduction factor, and typical loss evaluation.

Assessment: This includes an examination and/or assignments/projects. The examination assesses the students' understanding of the materials related to power quality and corona phenomena discussed in the lectures and tutorials. The assignments/projects test students' competence in applying the methods in solving practical problems in relation to power quality and corona performance of transmission lines.

Advisable prior study: assumed prior knowledge in power systems [at a level equivalent to ELEC3305 Power and Machines and ELEC4307 Power Transmission and Control]

Contact hours: 52 (lectures: 26 hrs; tutorials: 11 hrs; project: 15 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8344>

ELEC8345 - Power Systems Control

Credit: 6 points

Availability: not available in 2008

Outcomes: Students develop an in-depth understanding of both off-line and online control measures in power network systems including those used in distribution networks.

Content: This unit covers the following topics:

1. voltage control measures; switching control; automatic excitation control; transformers off-nominal tap position control; shunt reactors and capacitors; static VAR compensators; and voltage control in layered power networks;
2. reactive-power balances in transmission networks; dependence on the active-power transmission level; control of reactive-power flows; automatic reactive power compensation; modelling of compensators related to steady-state operation; voltage control response of compensators; compensators for countering the effects of pronounced load unbalance; and reactive-power compensators in transient operating modes;
3. frequency control; measures of control; load forecasting and generator scheduling; on-line control measures; system power-frequency characteristics; inter-area transfer;

multi-area co-ordinating control strategy; area autonomy; under-frequency load shedding; and

- control and monitoring automation in distribution networks; distribution feeder automation; network configuration by automatic switching control; and network loss reduction by switching control.

Assessment: This includes an examination and/or assignments/projects. The examination assesses the students' ability in formulating control measures for achieving the system responses required in steady-state operation and in transient operating modes. The assignments/projects test their competence in designing control measures and evaluating their performance.

Advisable prior study: assumed prior knowledge in power systems [at a level equivalent to ELEC3305 Power and Machines and ELEC4307 Power Transmission and Control]

Contact hours: 59 (lectures: 26 hrs; tutorials: 13 hrs; project: 20 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8345>

ELEC8346 - Power Systems Modelling

Credit: 6 points

Availability: Semester 2

Outcomes: Students develop an in-depth technical competence in modelling power systems in different operating modes.

Content: This unit covers steady-state network model; sparsity programming methodology; modelling in phase coordinates; applications of network models in load flow; short-circuit fault; harmonic and transient stability analyses; dynamic modes of operation subsequent to a disturbance; forms of instability; factors on which the limits of stable operating modes depend; modelling requirements for dynamic analysis; typical solutions; transformation between alternative systems of variables; excitation controller and prime-mover and governor modelling; network modelling in dynamic analysis; requirements relating to detail of modelling; dynamic load modelling; complete multi-machine formulation in d-q axes; axis transformation; numerical integration; compensator modelling in dynamic analysis; contribution of compensators to dynamic response; eigenvalue analysis in small-disturbance stability studies; and investigations of voltage collapse with dynamic models.

Assessment: This includes an examination and/or assignments/projects. The examination assesses the student's ability to formulate models for representing power systems in a range of operating conditions. The assignments/projects test their competence in evaluating power systems responses and understanding their significance in terms of network system design and operation.

Advisable prior study: assumed prior knowledge in power systems at a level equivalent to ELEC3305 Power and Machines and ELEC4307 Power Transmission and Control

Contact hours: 52 (lectures: 26 hrs; tutorials: 11 hrs; project: 15 hrs)

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8346>

ELEC8347 (Part 1), ELEC8348 (Part 2), ELEC8349 (Part 3) - Dissertation ME (PSE)

Credit: 18 points (Parts 1 to 3)

Availability: Semester 1 and Semester 2

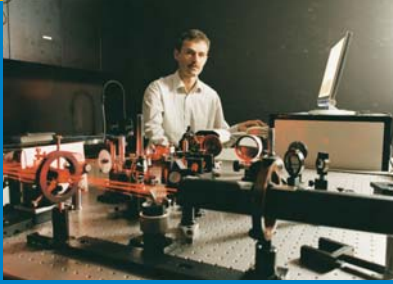
Outcomes: Students gain experience in the conduct of an investigation of a particular advanced topic in power systems engineering; develop and improve their skills in sourcing and synthesis of information, problem solving, design, analysis and communicating results; and increase their level of skill in one or more of the areas of power systems engineering. They are required to submit a technical dissertation on a topic approved by the Head of the School of Electrical, Electronic and Computer Engineering and to participate in any prescribed seminars.

Content: This unit is taken over three successive semesters and parts 1, 2 and 3 must be completed to fulfil the requirements of the unit. Students can commence the unit in either semester 1 or semester 2.

The unit is an individual investigation of an advanced topic in power systems, taken as part of the Master of Engineering in Power Systems. The investigation involves the study of the problems, design and implementation of possible solutions. The unit develops skills in problem solving, design, analysis and testing. Students are required to submit a project proposal, present a seminar and submit a dissertation detailing all aspects of the project.

Assessment: This is conducted through the following means: (1) a written project proposal submitted at the end of the first project semester (to provide feedback to students on their progress); (2) presentation of a seminar on their project (measuring presentation skills) in the second project semester; and (3) written technical dissertation at the conclusion of the project which incorporates an assessment of the student's overall performance by a committee of three members chaired by the project supervisor.

Unit Web Page: <http://student.ee.uwa.edu.au/units/elec8347>



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