Prifysgol Wrecsam
Wrexham University

Module specification

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Module Code	ENG7XB5
Module Title	Machine Learning for Electrical Systems
Level	Level 7
Credit value	20
Faculty	FACE
HECoS Code	100188
Cost Code	GAME
Pre-requisite module	N/A

Programmes in which module to be offered

Programme title	Core/Optional/Standalone
MSc Engineering (Electrical)	Core

Breakdown of module hours

Learning and teaching hours	18 hrs
Placement tutor support hours	0 hrs
Supervised learning hours e.g. practical classes, workshops	18 hrs
Project supervision hours	0 hrs
Active learning and teaching hours total	**36 hrs**
Placement hours	0 hrs
Guided independent study hours	164 hrs
Module duration (Total hours)	**200 hrs**

Module aims

This module fuses advanced theoretical study with applied experimentation, enabling learners to interrogate, test, and extend current professional and research practice. Through a combination of conceptual exploration and laboratory enquiry, students cultivate critical evaluation, leadership, and evidence-based decision-making skills suitable for professional or doctoral progression.

This module Machine Learning for Electrical Systems aims to introduce students to the advanced concepts, methodologies and practical challenges of applying machine learning to complex electrical engineering systems, enabling them to analyse large data sets, critically evaluate and justify appropriate algorithms, and implement robust, data-driven solutions using established programming practices.

Module Learning Outcomes

At the end of this module, students will be able to:

1	Formulate and analyse complex electrical engineering problems as machine-learning tasks (e.g., classification, regression, anomaly or fault detection), selecting appropriate electrical engineering data representations and assumptions and justifying the modelling approach.
2	Design, implement and refine machine learning solutions using appropriate software tools, environments and libraries, including the ability to interpret, modify, debug and improve third-party code for deployment on representative electrical engineering data sets.
3	Critically evaluate and compare alternative machine learning methods experimentally using suitable performance metrics such as environmental & societal, over the entire life cycle of the process and communicate results clearly, proposing and justifying improvements to minimise adverse impacts (AHEP-4 M7).

Assessment

Indicative Assessment Tasks:

This section outlines the type of assessment task the student will be expected to complete as part of the module. More details will be made available in the relevant academic year module handbook.

Assessment 1:

Students will produce an individual portfolio in which they identify and justify an appropriate open-source electrical engineering dataset from repositories such as Kaggle, GitHub, Google Dataset Search or UCI (or create a new dataset via simulation or synthetic generation), formulate a data-driven electrical engineering problem that integrates unsupervised learning (e.g., clustering, anomaly detection or dimensionality reduction) with supervised learning (i.e., classification and/or regression), and implement, experimentally validate and critically compare suitable machine learning frameworks, communicating results clearly and proposing evidence-based improvements.

Assessment number	Learning Outcomes to be met	Type of assessment	Duration/Word Count	Weighting (%)	Alternative assessment, if applicable
1	1-3	Portfolio	4000	100	N/A

Derogations

Credits shall be awarded by an Assessment Board for those modules in which a mark of at least 50% has been achieved, with a minimum mark of 40% in each element of assessment.

Learning and Teaching Strategies

Learning integrates advanced theoretical study with applied experimentation, enabling students to test and extend current professional and research practice. Face-to-face sessions are complemented by virtual discussions, simulations, and case studies to support analytical depth. Tutorials and supervision focus on independent enquiry, innovation, and leadership in addressing complex challenges.

Welsh Elements

This module will be delivered through the medium of English; however, students have the option to submit their assessments in the medium of Welsh. While this module is not currently offered fully through Welsh, Welsh language support and guidance are available, and some learning materials or tutorial discussions may incorporate Welsh elements where appropriate. To further promote bilingual learning, all students have the opportunity to take the 20-credit Welsh for STEM short course, designed to develop confidence and subject-specific language skills in both English and Welsh.

Indicative Syllabus Outline

- Definitions and types of machine learning; framing electrical engineering case studies (e.g., condition monitoring, fault detection, load/renewables forecasting) as classification, regression, clustering or anomaly detection problems.
- Data challenges and problem delineation: signal/data acquisition, preprocessing, feature engineering, dimensionality reduction, data quality issues (noise, imbalance, drift), and assumptions/constraints affecting model selection.
- Supervised learning implementation: model training pipelines for classification/regression; core algorithms including support vector machines, decision trees, ensemble methods, random forests, and others.
- Unsupervised and deep learning implementation: clustering (soft and hard clustering) and other unsupervised techniques (dimensionality reduction); neural networks (basic architectures and training) for deep learning; introduction to natural language processing where relevant to engineering text/log data; tracing, debugging and improving existing third-party ML code.
- Experimental evaluation and comparison: train/validation/test strategy, cross-validation, hold-out method, selection of performance metrics (e.g., accuracy/F1, ROC-AUC, RMSE/MAE), robustness checks, and comparative studies across candidate ML methods.
- Results presentation and improvement proposals: clear visualisation and reporting of outcomes; error analysis and ablation studies; proposals for improvement (e.g., hyperparameter optimisation, feature redesign, regularisation, alternative models), including an introduction to applying reinforcement learning for control/decision problems where appropriate.

Indicative Bibliography

Please note the essential reads and other indicative reading are subject to annual review and update.

Essential Reads:

E. Alpaydin, Introduction to Machine Learning, 4th ed. Cambridge, MA, USA: The MIT Press, 2020.

Other indicative reading:

A. Burkov, Machine Learning Engineering. True Positive Inc., 2020.

A. Burkov, The Hundred-Page Machine Learning Book. Andriy Burkov, 2019.

M. P. Deisenroth, A. A. Faisal, and C. S. Ong, Mathematics for Machine Learning. Cambridge, UK: Cambridge University Press, 2020.

Plus, various others to be signposted on Moodle.

Administrative Information

For office use only	
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Date and details of revision	
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