UNIVERSITY of BRADFORD

Module Descriptor

Module Details	
Module Title	Engineering Mathematics and Machine Learning
Module Code	ENM5007-B
Academic Year	2024/5
Credits	20
School	School of Engineering
FHEQ Level	FHEQ Level 5

Contact Hours	
Type	Hours
Lectures	48
Tutorials	24
Laboratories	8
Directed Study	120

Availability	
Occurrence	Location / Period
BDA	University of Bradford / Academic Year

Module Aims

To establish an appreciation and working knowledge of the premise that analytical (deterministic) and statistical & machine learning methods are components of a larger integrated tool kit for addressing and evaluating solutions to a variety of multi-variate engineering-based problems.

Outline Syllabus

SEMESTER 1: Engineering Analysis
01 Partial differentiation: multi-variate functions, partial derivatives, differentials and increments, turning points and classification, application to a range of engineering problems.
02 Multiple integration: notation and description, domains of integration, change of order, using polar coordinates, application to a range of engineering problems.
03 Laplace transforms: (i) standard transforms, shift theorems, derivatives and integrals; (ii) solution of ODEs including systems, (iii) Heaviside & Dirac delta functions, convolution.
04 Vector and matrices: (i) vector calculus: gradient, divergence, curl, Laplacian, applications to engineering, (ii) matrix eigenvalues and eigenvectors, application to engineering (e.g. material deformation, differential equations)
05 Fourier analysis: (i) Fourier series, waves, representing periodic functions by trig. series, even and odd functions, half-range series, complex form of the Fourier series, solution of the heat equation, (ii) Fourier transforms, relation to Fourier series, even and odd functions, convolution.

SEMESTER 2: Statistics and Machine Learning:
Statistics & Machine Learning; methodologies of machine learning; Engineering statistical thinking; data collection and presentation; modelling random behaviour; estimation and testing; building empirical models through linear regression analysis; design of engineering experiments; introduction to response surface methodology and neural networks; application to statistical quality control and life data analysis. Specific engineering applications and context will be explored.

Learning Outcomes

Outcome Number	Description
01	Formulate the mathematical principles for handling analytical and machine learning (including statistical) aspects of the course of study. Understand variability underpinning engineering experiment, will have the knowledge required to plan & design engineering experiments to collect data, to carry out a variety of statistical tests and types of analysis on the data, to interpret the results, and to develop and validate theoretical and empirical models of engineering processes.
02	Apply a range of mathematical and machine learning techniques to the formulation and solution of general and specific (chemical, civil, electrical, industrial, mechanical, medical) engineering problems. Apply a range of statistical tests to engineering data, use statistical modelling techniques to derive empirical models for engineering systems, apply statistical models to process control, and utilise a specialised software package.
03	Use mathematical and machine learning methods for systematic problem solving. Use a range of advanced transferable skills in mathematical model development and statistical data presentation and interpretation.

Learning, Teaching and Assessment Strategy

Knowledge (theory, calculation methodology, application, interpretation) is disseminated in online lectures and is practiced in tutorial classes, with further practice and both general and specific (chemical, civil, electrical, industrial, mechanical, medical) engineering context being established in discipline groups.
Machine learning skills are taught and practiced in computer laboratory sessions. Oral feedback is given during computer laboratory sessions, exercise classes, and tutorial groups. Written feedback will be provided with marked in-session coursework assessments, both formative time-limited take-home items (with later live marking through online seminar sessions for self-marking and gap-analysis to inform self-directed additional study) and summative items.

The assessment reflects module content and summative requirements:
a. Mathematical discipline skills are assessed in take-home time-limited open-book items (supports feedback); b. Machine learning skills are assessed in computer laboratory sessions (supports written feedback) and a final examination.

This module satisfies the below Learning Outcomes as specified by the Accreditation of Higher Education Programmes: Fourth Edition (AHEP4) as published by the Engineering Council in-line with the UK Standard for Professional Engineering Competence (UK-SPEC). These outcomes specify five key areas of learning which partially (C) or fully (M) meet the academic requirement for CEng registration: Science and Mathematics (1), Engineering Analysis (2-4), Design and Innovation (5-6), The Engineer and Society (7-11), and Engineering Practice (12-18). Further details of these learning outcomes can be found at https://www.engc.org.uk/ahep/ M1, C1, M2, C2,

Mode of Assessment

Type	Method	Description	Weighting
Summative	Examination - Closed Book	End of Semester 1: Formal closed-book examination (2:00HR) answering selection of questions on analysis topics	50%
Summative	Long-Time Limited Online Examination	Semester 2: Coursework Report - complete online in open-book exam conditions within the time limit.	15%
Summative	Examination - Closed Book	Semester 2: Statistics closed-book exam - answer all questions within the time limit.	35%
Formative	Examination - Open Book	Answer all questions assessments at appropriate points in module delivery (Semester 1) with subsequent live worked solutions for self-marking and gap analysis, and full solution upload.	N/A

Reading List

To access the reading list for this module, please visit https://bradford.rl.talis.com/index.html

Please note:
This module descriptor has been published in advance of the academic year to which it applies. Every effort has been made to ensure that the information is accurate at the time of publication, but minor changes may occur given the interval between publishing and commencement of teaching. Upon commencement of the module, students will receive a handbook with further detail about the module and any changes will be discussed and/or communicated at this point.
