UNIVERSITY of BRADFORD

Module Descriptor

Module Details	
Module Title	Modelling and Optimisation
Module Code	ENM7005-B
Academic Year	2020/1
Credits	20
School	Department of Mechanical and Energy Systems Engineering
Subject Area	Engineering Mathematics
FHEQ Level	FHEQ Level 7
Pre-requisites	N/A
Co-requisites	N/A

Contact Hours	
Type	Hours
Lectures	24
Tutorials	12
Laboratories	4
Directed Study	160

Availability	
Occurrence	Location / Period
BDA	University of Bradford / Semester 1

Module Aims

To establish working knowledge of the role and importance of modelling and optimisation within modern (science and) engineering practice, with evidence and practice to demonstrate that it is just one component of an integrated tool kit that includes analytical, numerical, simulation, and statistical methods for addressing, evaluating, and improving multiple solutions to science and engineering-based problems.

Outline Syllabus

MODELLING

Building empirical and surrogate models through linear multiple regression analysis; design of engineering experiments; introduction to response surface methodology; Designed of Experiments methodology, including factorial experiments, fractional factorials, custom and optimal designs; Statistical models based on physical experiments; analysis of residuals; Planning and managing an experiment in practice; Success criteria for a prediction equation; selecting terms in a polynomial model; underfitting and overfitting model validation; Dealing with background variation. Using a prediction equation with noise factors, including Monte Carlo methods; Computer based experiments; space-filling / Latin Hypercube DoEs, nonlinear interpolation models including Neural Networks, Radial Basis Functions and Gaussian Kriging. Engineering case studies ? both physical experiments and computer based experiments. OPTIMISATION Formulation: terminology, translating descriptive engineering design problems into mathematical optimisation problems, constrained and unconstrained problems, formulating constraints imposed on engineering system behaviour, global and local optima. Numerical optimisation: one-dimension, deterministic methods. Constrained problems (Kuhn-Tucker optimality, Lagrange multipliers, Penalty functions, SUMT). Bio-inspired techniques. Multi-modal optimisation. Multi-objective problems: Pareto-optimal solutions, numerical approaches (discrete and continuous criteria). Multidisciplinary optimisation.

Learning Outcomes

Outcome Number	Description
01	Demonstrate a critical understanding of design of experiments and response surface methodology in theory and practice as applied to engineering problem-solving, problem prevention and product development.
02	a. Plan and run statistically based experiments appropriate to a wide variety of engineering scenarios. b. Fit and validate response surface models to the resulting data. c. Use RSMs to understand the impact of variation on system performance.
03	Demonstrate advanced statistical experimentation skills, use of specialised packages for DoE analysis, communicate effectively in a project team and contribute to teamwork facilitation
04	Knowledge & Understanding: On successful completion of this module you will be able to critically evaluate the fundamental concepts of design optimisation and select, implement and assess a range of appropriate optimisation techniques.
05	Subject-Specific Skills: On successful completion of this module you will be able to formulate and solve an optimisation problem related to engineering design.
06	Personal Transferable Skills: On successful completion of this module you will be able to collate and manage data, and apply scientific method, IT skills and complex systematic problem-solving strategies.

Learning, Teaching and Assessment Strategy

N/A

Mode of Assessment				
Type	Method	Description	Length	Weighting
Summative	Coursework	Answer questions covering syallbus areas on optimisation	N/A	50%
Summative	Coursework	2,500 word individual report on the application of DoE, RSM and optimisation methodology to an engineering problem set	N/A	50%
Formative	Coursework	Answer all questions assessments and individual questions at appropriate points in module delivery with subsequent live worked solutions for self-marking and gap analysi	N/A	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.

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