

ENM7005-B Modelling and Optimisation

Modelling Coursework Outline

Module Aims

To establish an appreciation for the role of modelling and optimisation within modern science and engineering practice and to provide evidence that modelling and optimisation is an integrated tool kit (that includes analytical, simulation, and statistical methods met at earlier FHEQs) for addressing, evaluating, and improving multiple solutions to complex science and engineering-based problems.

Coursework Learning Outcomes

- 1 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.
- 2 a. Plan and run statistically based experiments appropriate to a wide variety of engineering scenarios. b. Fit and validate empirical transfer functions to the resulting data. c. Use transfer functions to understand the impact of variation on system performance.
- 3 Demonstrate advanced statistical experimentation skills, use of specialised packages for DoE analysis, communicate effectively in a project team and contribute to teamwork facilitation.
- 6 Collate and manage data, and apply scientific method, IT skills and complex systematic problem-solving strategies.

Modelling Coursework Portfolio

The coursework component for the Modelling & Optimisation module (50% of the overall assessment) is based on an independent student led experiment and analysis – as described below.

Task brief

You are expected to submit a technical report no longer than 2,500 words length (circa 10-12 pages of text including tables and graphical output from the software used for modelling), based on an engineering modelling / metamodeling Case Study chosen by the students*. The report is expected to cover the analysis of the technical problem identifying:

- engineering factors (as modelling parameters likely to have significant influence on the response of interest);
- critical discussion / planning of the modelling strategy – justifying the choice of the experimentation strategy (screening experiments followed by detailed optimal experiments, or space filling design of experiments);
- evaluation of the DoE plan;
- collection of data from the chosen Case Study;
- fit a response surface model – arguing the model choice, and evaluate the model quality using statistical indicators – with interpretation;
- use the model to derive an optimal solution against a set of criteria.

*A typical experiment would be based on a computer simulation, similar to the catapult simulation experiment used in class.

The default case study is rocket design simulator available at <http://openrocket.info/>.

Students can use any parametric CAE models that they have previously developed (e.g. part of their final year project), or any simulation models available in Matlab or Simulink – with the aim of developing metamodels by applying the methodology covered in the course.

Tutorial examples and case studies provided during tutorial sessions can be reused for the purpose of the coursework. Students can work in pairs (or small groups) to carry out the experiments – **but the reports must be individual**. Where students have worked in a small group collaboration must be clearly acknowledged (i.e. the list of students that have collaborated for the experiment must be provided up front in the report).

NB The report should be based on / include the Colab Notebook, i.e. the Colab file must be included with the Canvas submission. Submissions fully edited in Colab notebook format are acceptable – provided they have the appropriate structure, and a pdf format file is also submitted.

As a guideline, the report should have a structure as outlined in the table below.

Executive summary	
Contents list	
Introduction and Objectives	Provide a background description to the engineering problem / project tackled; State the specific objectives of the investigation; Scope / Limitations and constraints
Methodology	Outline the methodology, detailing the planning of the experiments and the analysis / modelling strategy.
Results and analysis	Present the results with the appropriate discussion and interpretation.
Discussion	Reflection on the methodology, results and implications Reflection on personal learning
Conclusions and recommendation	Succinct summary of main conclusions and recommendations – for implementation and further work.
References	
Appendices	The Colab output could be either included as an appendix or integrated with the main report. NB You should also submit the Colab notebook file .

Weight

Assessment Criteria and marking scheme – the detailed marking rubric is annexed!

Project setup <ul style="list-style-type: none"> Clarity of presentation of project background, objectives and scope 	10%
Methodology <ul style="list-style-type: none"> Selection of appropriate statistical methods/ tools for the engineering problem, including justification of why these tools are appropriate / were selected 	25%
Results and analysis <ul style="list-style-type: none"> Correct application of the statistical tools and interpretation of the results 	30%
Discussion, conclusions and recommendations <p>Richness of discussion:</p> <ul style="list-style-type: none"> What do the results show / what conclusions can be drawn from them Reflection on methodology: why was the methodology appropriate? could it be improved? what other tools could have been used? any cautionary notes? Summarised conclusions and recommendations – for implementation and further work 	20%
Overall report presentation <ul style="list-style-type: none"> Report structure Clarity of technical language and explanation Completeness of support data and information, including appendices 	15%

Total

100%

Report submission

Your report must be submitted in electronic form through Canvas – details of submission procedure will be posted in Week 10.

Submission Deadline: Wednesday 10th January 2024 @ 4pm.

THIS IS AN INDIVIDUAL COURSEWORK EXERCISE. THE WORK AND THE REPORT YOU SUBMIT MUST BE ENTIRELY YOUR OWN.

The University of Bradford Regulations include a policy on plagiarism, the copying of material and representation of it as one's own work. If you make use of material from any source, you must clearly identify it as such, the report must be written in your own words, and if you quote any material you must identify it and reference it in the correct manner. The University uses the 'Turnitin' software to check all coursework for evidence of plagiarism; this software will identify worldwide sources of text, and will also identify similarities between reports submitted by different students. If you have any questions about this, please ask the module team.

Appendix 1: Coursework Marking Rubric

Category	0-30%	30-40%	40-50%	50-60%	60-70%	>70%
Background to the problem <div>>70%</div>	No background given.	Limited information provided no reason of why the study is undertaken	Basic background given providing justification of the work	Adequate background provided clarifying the problem tackled in the report	Good background, clarifying issues and the need for the report.	Excellent background, providing clear yet concise outline of the problem tackled by the report.
Clarity of aim, objectives and scope <div>>70%</div>	No clear aims, objectives and scope	Limited definition of aims, objectives and scope	Basic definition of aims, with incomplete objectives and scope	Adequate definition of aims, objectives and scope.	Clear definition of aims, objectives and scope	Clear and complete definition of aims objectives and scope with justification.
Methodology <div>50-60%</div>	No discussion of methodology	Very limited discussion of methodology	Basic discussion of methodology - mostly outline, with no justification	Adequate description of methodology, with limited justification	Good description of methodology with coherent justification	Excellent methodology with clearly justified sequence of process, methods and tools.
Depth and breadth - appropriate coverage <div>60-70%</div>	Insufficient coverage of the methods and tools	Limited coverage of the methods and tools - at insufficient depth to demonstrate adequate learning	Limited coverage of the methods and tools or rather basic depth of application	Adequate coverage of tools and just sufficient depth to demonstrate learning (knowledge and skills)	Good coverage of tools and sufficient depth to demonstrate learning (knowledge and skills)	Excellent coverage and depth, with evidence of ingenuity and innovation in the application of methods and tools
Integrity of the application of the tools <div>50-60%</div>	Incorrect application of methods and tools.	Integrity of tools and methods insufficient to demonstrate learning	Some tools and methods applied partially correct	Reasonable integrity in the application of most tools and methods demonstrating adequate learning.	Good integrity in the application of tools and methods demonstrating good learning.	Excellent integrity in the application of all tools and methods demonstrating mastery of knowledge and skills.
Completeness of the analysis <div>40-50%</div>	Incomplete analysis in all aspects.	Limited completion of some parts of the analysis.	Limited completion of most parts of the analysis.	Adequate completion of most parts of the analysis.	Good completion of most parts of the analysis.	Excellent, complete in all aspects.
Interpretation of the results <div>50-60%</div>	No interpretation of the results.	Limited interpretation fo the results.	Basic presentation and interpretation of the results.	Adequate presentation and interpretation of the results.	Good, complete presentation and interpretation fo the results.	Insightful presentation of the results of the analysis
Critical review of results and methodology <div>60-70%</div>	No critical review of results	Limited discussion, mostly summary - lacking criticality	Basic discussion, limited critical insight	Adequate discussion of the results, with limited reflection on methodology	Good discussion of the results and their significance, with reflection on methodology and completeness of the study.	Excellent, insightful critical discussion / review of the work covering both results and methodology.
Reflection on personal learning <div>60-70%</div>	No reflection on personal learning	Limited reflection on personal learning	Some basic reflection on personal learning	Adequate reflection on personal learning, directly related to the work	Good reflection on personal learning and gain from the module	Excellent reflection on personal and organisational learning
Conclusions <div>60-70%</div>	No conclusions	Limited conclusions, not linked to the work presented	Basic conclusions, not linked to the work completed	Adequate conclusions, partially linked to the work completed	Good - complete conclusions, justified by the work	Complete and comprehensive conclusions, fully justified by the work and discussion
Recommendations <div>60-70%</div>	No recommendations	Limited recommendations, not underpinned by the work presented and conclusions	Basic recommendations, not underpinned by the work presented and conclusions	Adequate recommendations, partially linked to the work presented and conclusions	Good - actionable recommendations	Insightful recommendations both for implementation and further work
Structure <div>60-70%</div>	No clear structure.	Some attempt to structure content using the paper template.	Basic structure of chapters / sections and the paper / report template used	Adequate structure with heading content and signposting	Good structure with suitable headings. Appropriate content in most of the	Excellent structure with suitable headings. Appropriate content in each
Diagrams, graphs, tables. <div>60-70%</div>	No diagrams/graphs/tables used	No diagrams/graphs/tables used.	Few diagrams/graphs/tables used and no appropriate signposting. No analysis or significance identified.	Diagrams/graphs/tables relevant to assignment with some sign-posting. Significance identified but	Good use of relevant diagrams/graphs/tables, signposting clear. Significance identified.	Excellent diagrams/graphs/tables have been used with clear signposting. Good analysis
Language, spelling and grammar. <div>60-70%</div>	Poor spelling and grammar. Poorly constructed paragraphs. No clear topic.	Poor spelling and grammar. Poorly constructed paragraphs. No clear topic.	Adequate spelling and grammar. Adequately constructed paragraphs. No clear topic.	Spelling and grammar generally good. Appropriate paragraphs with some sign-posting. Ideas not clearly supported with evidence.	Occasional errors with spelling and grammar. Good use of paragraphs and appropriate signposting. Ideas related to evidence.	Clear language. Paragraphs and signposting are used appropriately. Ideas are clearly expressed and supported with evidence.
Sources and referencing. <div>50-60%</div>	No references or attribution of the source material. No citation or list of references.	Limited number of sources used. No citation or list of references.	Limited number of sources and citations. List of references incomplete.	Adequate number of sources and citations. List of references incomplete.	Good use of citations to indicate analysis. List of references provided.	Good use of up-to-date and relevant sources and citations, going beyond the course materials. List of references complete.